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Volume 2 — Number 8

AMERICAN SOCIETY OF CIVIL ENGINEERS FOUNDED 1852

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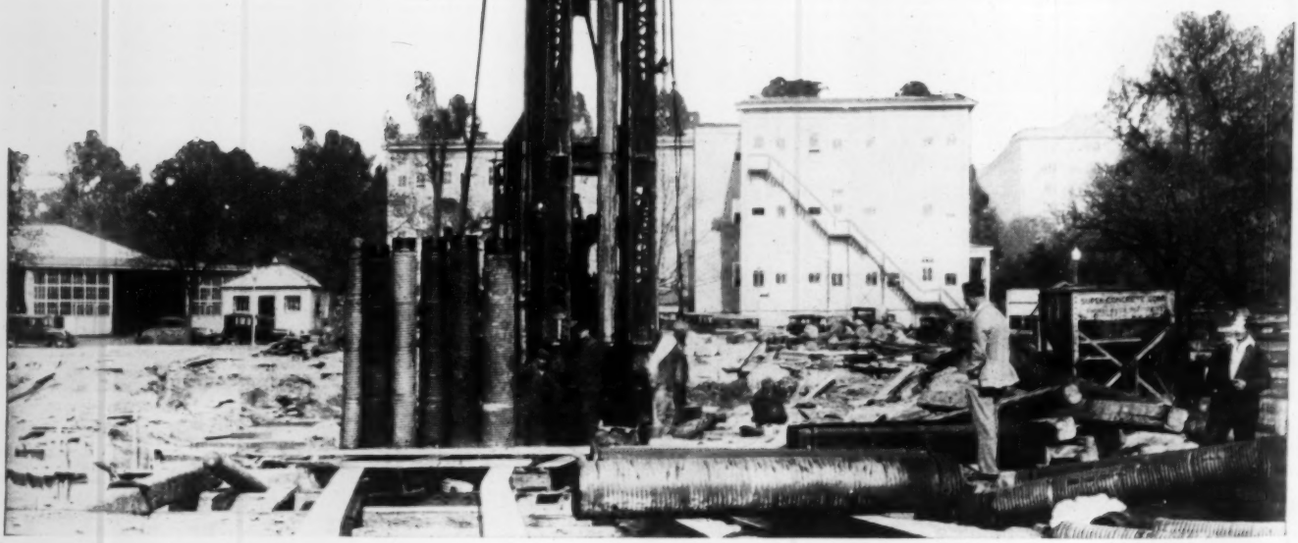

Among Our Writers

HERBERT D. VOGEL, as an officer in the Corps of Engineers of the U.S. Army, made a two-year inspection trip to European hydraulic laboratories in 1928 and 1929. For his studies at the Berliner Technische Hochschule during this time he obtained the degree of Dr. Ing.

JOHN PAUL DEAN spent two years as instructor at the U.S. Military Academy. After ten years of close contact with river and harbor work, he was sent in 1928 and 1929. After ten years of close contact with river and harbor work, he was sent in 1928 and 1929 to make an investigation of hydraulic laboratories and methods of hydraulic research and design in Europe.

CALVIN V. DAVIS has been identified with the Ambursen Construction Company since 1923. Among the dams upon the design of which he has been engaged is the Roderiguez Dam now under construction near Tijuana, Lower California.

FRANKLIN HUDSON, JR., early in his career became associated with the Benham Engineering Company, consulting engineers of Kansas City, and was engaged upon the design and construction of sewerage works, water supply, paving, and pipe line projects throughout the State of Oklahoma. In 1928 Mr. Hudson was awarded the Collingwood Prize for Juniors.

BILLINGS WILSON is considered a transporation expert. After a varied experience in railroading, he was employed by Francis Lee Stuart, consulting engineer, on studies for coal storage facilities and for the terminals of the proposed Hudson River Bridge at 57th Street.

WILLEM RUDOLFS was born and educated in Holland. Since 1922 he has been Chief of the Sewage Research Division of the New Jersey Agricultural Experiment Station and Professor at Rutgers University. During the last ten years he has devoted his time to theoretical and practical studies of the underlying principles of physical, chemical, and biological sewage stabilization.

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FRED A. NOETZLI was educated in Switzerland and for several years practiced abroad. He came to the United States in 1915 and, since 1919 has specialized in the design of dams. He has contributed liberally to the technical literature of this country and, in 1920, was awarded the Society's J. James R. Croes Medal.

ARTHUR E. MORGAN is well known as a flood control expert, particularly in his capacity as Chief Engineer of the Miami Conservancy District. Since 1920, he has been president of Antioch College. He is also president of the Dayton Morgan Engineering Company, Dayton, Ohio.

O. S. READING entered the U.S. Coast and Geodetic Survey as a Deck Officer in 1915. After various surveys on the Alaska, the Philippine, and the United States coasts, he was placed in charge of aerial phototopographic surveys of the Coast and Geodetic Survey in 1928.

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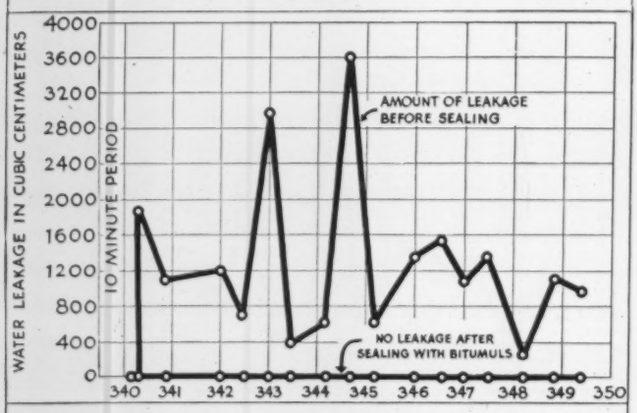

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AUGUST 1932

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NUMBER 8

Geometric Versus Hydraulic Similitude

Factors to Be Considered When Using Models to Study Flow in Open Channels

By HERBERT D. VOGEL
DIRECTOR, U.S. WATERWAYS EXPERIMENT STATION, VICKSBURG, MISS.
FIRST LIEUTENANT, CORPS OF ENGINEERS, U.S. ARMY
and JOHN PAUL DEAN
ASSISTANT TO DISTRICT ENGINEER, FIRST LIEUTENANT, CORPS OF ENGINEERS, U.S. ARMY, NEW ORLEANS, LA.

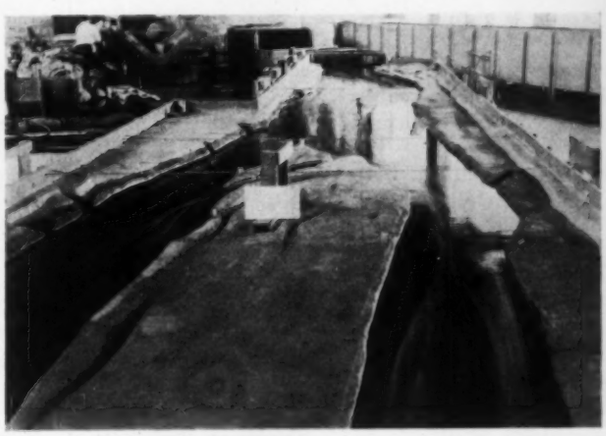
IN 1875 the French engineer, L. Fargue, used a model of the Garonne River to study methods of improving the channel of that stream. His is said to have been the first recorded attempt to use small scale models to solve a problem regarding flow of water in a river channel with shifting bed. During recent years small models have been used rather generally both here and abroad to predict the action of flowing water in a proposed design and to avoid costly errors in construction. At Vicksburg, the Mississippi River Commission maintains the U.S. Waterways Experiment Station, the largest laboratory in America, for the intensive study, by means of models, of the Mississippi River and other waterways.

In dealing with this subject, Lieutenants Vogel and Dean point out that an experimenter must have exact knowledge of the relationship between the many coefficients affecting flow in a model and in its prototype, and must realize that, even with exact scale duplication, the effect on flow is distorted in various ways.

When Lieutenant Vogel delivered a paper on this topic before the American Association for the Advancement of Science at its meeting in New Orleans in December 1931, it was the subject of wide and favorable comment, including a discussion by Lieutenant Dean. Their joint paper constitutes a combination and revision of their previous independent treatment of this important question.

WHEN it is necessary to study, by means of a model, a reach of river several hundred miles long, as in the case of the Mississippi, with distances between levees as great as 10 or 15 miles, the selection of a small horizontal scale is imperative if the model is to be kept within reasonable size so as to meet the requirements of workability, economy, and available space. But if an extremely small scale is chosen, it may often be necessary to use a greater vertical scale to produce measurable depths and turbulence in the model. The degree of permissible distortion appears to vary according to a function of the horizontal scale. That is to say, where a distortion of 5 may be the maximum allowable for a horizontal scale of 1:100, a distortion of 20 may not be unreasonable in the case of a model on a basic scale of 1:5,000. Naturally, each case must be considered separately, for the degree of permissible distortion will vary with such characteristics as slope, channel and overbank sections, and roughness of bed.

Great difficulties arise when the behavior of a small scale model of a large river or harbor is to be used as a basis for important conclusions as to the probable behavior of its prototype, for it is next to impossible to simulate exactly all the known natural conditions. In theory, of course, this might be done in cer-



Water Colored to Show Lines of Flow — Effect of Spur Dikes

MODEL OF WALKER'S BAR, OHIO RIVER (l = 1:720, d = 1:72)

tain special cases if it were possible to control independently and at will all the properties of the materials in the model as well as the forces involved. These properties include the density, viscosity, and surface tension of the fluid used in the model; and the size, shape, cohesion, and density of the solid materials. The external forces include gravity, friction, and barometric pressure.

Much has been said about geometric distortion in models and little about the distortion of other properties,

BUILDING THE OUTDOOR MODEL OF THE MISSISSIPPI RIVER
l = 1:2,400, d = 1:120

which occurs when the scale is reduced even though the model is undistorted geometrically. In practice, every model is distorted in some respects. The investigator must not be misled into overlooking complacently the less obvious distortions of properties and forces while he concentrates on avoiding geometrical distortion. The question is not whether distorted models will be used; it is, rather, how can the distortion that is bound to occur in every model be made least harmful?

BASIC PRINCIPLES OF SIMILITUDE

Basically, the principle of similitude is extremely simple, consisting merely of the comparison of dimensional quantities in the model with the corresponding quantities in the prototype. In this paper, the following notation will be used: the subscripts n and m will indicate conditions in nature and in the model, respectively; and lower case letters will indicate scale values of the function. Thus L_n will represent the length in the prototype; L_m, the corresponding length in the model; and l, the length scale. Then $l = \frac{L_m}{L_n}$. Similarly, the scale of area, a, will be represented by the ratio $\frac{A_m}{A_n} = \frac{{L_m}^2}{{L_n}^2}$, or, in the case of distortion, by $\frac{L_m D_m}{L_n D_n}$, where L and D stand for length and depth, respectively. Using known relationships as a basis, any scale value may be determined in the same way by appropriate substitutions.

Starting with the formula for velocity produced in a freely falling body by the influence of gravity, $V = \sqrt{2GH}$, we may write:

$$\frac{V_m}{V_n} = \frac{\sqrt{2GH_m}}{\sqrt{2GH_n}} = \frac{\sqrt{2GD_m}}{\sqrt{2GD_n}} = \frac{\sqrt{D_m}}{\sqrt{D_n}} \quad \ldots\ldots [1]$$

Whence,

$$v = \sqrt{d} \quad \ldots\ldots [2]$$

or, expressed in words, the velocity scale is equal to the square root of the vertical scale. This relationship, together with that for the time scale, $t = \sqrt{d}$, is known as Froude's law and is the basic equation for the determination of velocity scales in hydraulics and other sciences where gravity is the controlling influence. It should be noted, however, that this equation is for the effects of gravity only and is not applicable to conditions involving frictional or other coefficients. From it is derived the discharge scale:

$$q = l d^{3/2} \quad \ldots\ldots [3]$$

obtained by multiplying scale values for area and velocity.

In case the model is designed to show the effects of discharge over dikes, dams, or other structures functioning primarily by gravity, it is obvious that only the relationship $q = ld^{3/2}$, is directly applicable to an expression of the natural phenomenon involved. In the case of a weir, this relationship may be determined in another way, by applying the principles of similitude to standard weir formulas of the form $Q = KLD^{3/2}$ the K in this case disappearing as a constant in the resulting formula for similitude.

Turning now from the case of a model weir to the more general case of an ordinary reach of river, an entirely different set of controlling conditions is encountered. Gravity continues to be an important consideration, but such influences as hydraulic radius, slope, and roughness of bed now make their entrance to complicate the problem. No formula approaching perfection has been devised for the expression of discharge in open channels such as rivers, but the Chezy relationship, $Q = AC\sqrt{RS}$, is generally accepted as the most nearly applicable to all cases, and therefore serves as a basis for practically all determinations. In spite of the empirical character of all standard discharge formulas, they must be accepted until better ones can be developed to replace them. Considering particularly the Manning formula, $Q = \frac{1.486\, R^{2/3}\, S^{1/2} A}{N}$, a relationship for similitude can be derived in the same way as previously indicated. By dropping constants and substituting scale values for hydraulic radius, R; slope, S; area, A; and the coefficient N, there is evolved, as an expression of the discharge scale, $q = \frac{r^{2/3}\, s^{1/2}\, a}{n}$. If the model has been built according to simple distortion, that is, with no artificial adjustment of slope, and if the cross section is flat enough to permit the substitution of the mean depth, d, for r, it is found that:

$$q = \frac{d^{2/3}\, d^{1/2}\, ld}{l^{1/2}\, n} \quad \text{(approximately)} \ldots\ldots [4]$$

or,

$$q = \frac{l^{1/2}\, d^{13/6}}{n} = l^{1/2} d^2 \left(\frac{d^{1/6}}{n}\right) = k l^{1/2}\, d^2 \ldots\ldots [5]$$

which is considerably at variance with Equation 3, $q = ld^{3/2}$. In the case of a model designed to represent an overflow structure in a natural reach of river, the problem becomes that of reconciling these two relationships.

The customary method of accomplishing this result has been to assume the gravitational relationship as applicable to the flow in the miniature river and to provide an artificial slope or roughness that will reproduce, to scale, the water-surface profiles previously observed in nature. An objection to this method may be made on the ground that the added resistance to flow brought about by decreased slope or increased roughness reduces velocity and hence the transportation of sediment and the turbulence necessary to ensure the proper functioning of the model. It should be noted that practically every

theoretical determination of discharge in the model calculated by the gravity formula is larger than that found by actual measurement, and that therefore in nearly every case the stages must be artificially raised in the model to coincide with those of nature.

Turning now to the relationship $q = \frac{l^{1/2}\, d^{13/6}}{n}$, a primary difficulty is introduced by the presence of the coefficient n, which is never accurately determinable. By experiment, however, it has been found that for small scale models $\left(\text{those in which } l < \frac{1}{1{,}000}\right)$ built with mortar, and for models of intermediate scale $\left(\text{those in which } \frac{1}{1{,}000} < l < \frac{1}{500}\right)$ built with a sand bed, the value of n is nearly unity. Since this n is the ratio between the N of the natural river and the N of the model, there would appear at first to be an anomaly, for standard tables place the value of N in a reasonably good stretch of river at about 0.030 and at about half that in a concrete flume. The controlling factors of slope and hydraulic radius must be taken into consideration, however, and even casual thought will show that in a model river of small cross section much resistance will be encountered even when the surface is relatively smooth. This indicates that every model should be built with as smooth a surface as is economically possible, and that roughening should not be resorted to except on areas beyond the normal limits of the banks where it is necessary to simulate woods and underbrush. This idea appears to be a radical departure from accepted theory, for it indicates that N is not a constant and that it may be expected to vary with both R and S.

In solving hydraulic problems, with or without models, some empirically determined coefficients are usually involved, since it is rarely possible to base computations solely upon generally accepted physical laws and constants. Compensation for the effects of certain disturbing factors must be secured by the introduction of a coefficient determined by experience for a definite set of conditions, but varying uncertainly over a wide range when other conditions are imposed. An attempt to discover any direct or positive mathematical relationship between N and its controlling factors would be of course futile because of the many combinations of circumstances that may occur, but recent experiments conducted at the U.S. Waterways Experiment Station by Clarence E. Bardsley, M. Am. Soc. C.E., Professor of Hydraulic Engineering at the University of Missouri, indicate that N may be expected to increase materially with the slope. The investigations of Professor Bardsley thus serve to supply a possible explanation of the high values obtained for N in models where the slope may be 10 or 20 times that of nature, depending on the degree of distortion.

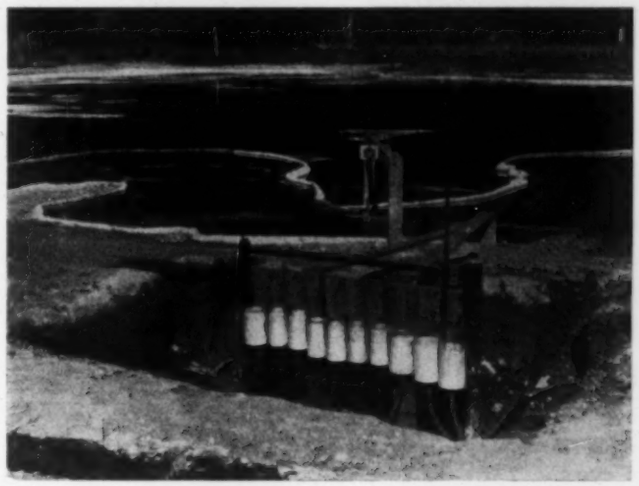
Assuming, on the basis of data obtained by experiment, that the ratio n is unity, the following formula is obtained for discharge in the model of a river:

$$q = l^{1/2}\, d^{13/6} \ldots\ldots\ldots\ldots\ldots\ldots [6]$$

The applicability of this formula as a means of determining the required discharge in a model is shown in Table I, which gives data in round numbers on experiments conducted at the U.S. Waterways Experiment Station.

A further interesting proof of the formula is found in its application to the results of European experiments. In the case of models built to a slope scale which does not result from normal distortion, the formula must be applied in the form, $q = lds^{1/2}$. Testing it for the Elbe River model of the Preussiche Versuchsanstalt, where $l = 1{:}200$, $d = 1{:}40$, and $s = 8{:}1$, q is found to equal 1:33,000. The value of q as determined by Professor Krey's experiments was 1:30,000.

The discharges given in the last line of Table I were determined for each model by varying the flow over the weir and adjusting the tail-gate until the flow line mea-



MULTIPLE GAGE RACK FOR MODEL OF THE MISSISSIPPI RIVER AND YAZOO BASIN

sured in nature had been definitely reproduced. The ratio between the measured discharge of the model and the corresponding measured discharge in nature was taken as the true scale for discharge. As shown by the table, these values are in close agreement with the theoretical determinations for channel flow, but are considerably at variance with the determinations by the gravity formula. To determine the relationship between linear and depth scales which will satisfy both conditions, the two formulas, [6] and [3], are equated, with the result that $l^{1/2} d^{13/6} = ld^{3/2}$.

TABLE I. COMPARISON OF THEORETICAL AND ACTUAL DISCHARGE Obtained from Tests Conducted at the U.S. Waterways Experiment Station

MODEL FORMULA	SMALL SCALE, CONCRETE SURFACE				SAND BED	
	A	*B*	*C*	*D*	*E*	*F*
	l = 1:4,800	1:4,800	1:2,400	1:1,200	1:720	1:720
	d = 1:360	1:200	1:120	1:48	1:72	1:72
$q = l^{1/2} d^{13/6}$	1:24,000,000	1:6,700,000	1:1,567,000	1:152,000	1:284,000	1: 284,000
$q = ld^{3/2}$	1:32,800,000	1:13,600,000	1:3,155,000	1:399,000	1:440,000	1:440,000
Measured q	1:21,000,000	1:7,200,000	1:1,570,000	1:150,000	1:300,000	1:280,000

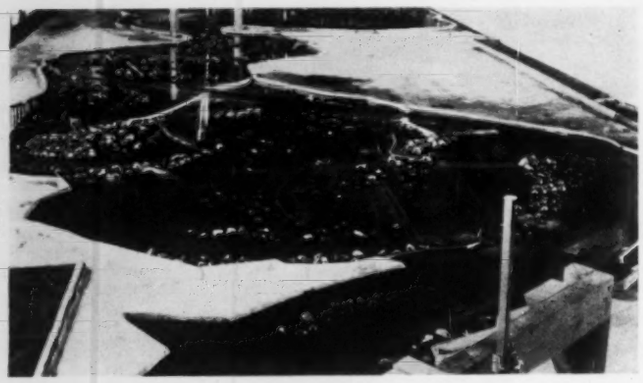
Whence,

$$d = l^{3/4} \ldots\ldots\ldots\ldots\ldots\ldots [7]$$

In the case of an undistorted model, there will be less tendency for N to be increased in the model, for the reason that the slope will remain virtually the same as that of nature. This being so, the quantity d should normally about equal n, both having values of between $^1/_2$ and $^1/_4$ if reasonable care has been taken in the selection of the surfacing. Considering the equation, $q = l^{1/2}\, d^2\, \frac{d^{1/6}}{n}$, in which $\frac{d^{1/6}}{n}$ is equal to unity, the relationship may be reduced to $q = l^{1/2}\, d^2$. Since the basic assumption here was that no distortion should exist, d must be made equal to l; whence, $q = l^{5/2}$, which equation is identical with that for discharge derived from the formula, $q = ld^{3/2}$, when d is made equal to l.

Thus it is found that an undistorted model will satisfactorily meet the requirements of both discharge relationships previously described, but that the model may be distorted and still satisfy the imposed conditions if d is made equal to the three-fourths power of l. This, of course, is more exactly true when the distortion is relatively large, as in the case of models with a basic linear scale less than 1:1,000.

Naturally, this ratio cannot be adhered to if it fails to satisfy the conditions for turbulent flow, or if it produces insufficient depths for measurement. In case this ratio must be discarded for these reasons, it is still possible to determine mathematically the desired dimensions for the prototype by the application of a determinable factor to the corresponding model dimensions.



MODEL OF THE MISSISSIPPI RIVER IN FLOOD NEAR GREENVILLE, MISS.
l = 1:4,800, d = 1:360

To clarify this statement, assume a model having a horizontal scale of 1:720 and a vertical scale of 1:72, in which the slope scale is represented by the ratio of distortion. Since 720 to the three-fourths power equals approximately 140, it is seen that a vertical scale equal to $^1/_{72}$ is too great for consistency with the formulas $q = ld^{3/2}$ and $q = l^{1/2}\, d^{13/6}$. For the assumed scales, q by the latter formula is determined as approximately 1:290,000, which indicates that sufficient flow is available within the laboratory to supply the model, and which also gives information as to the size of weir and weir box that will be required. After the model has been set up and trial runs have been made, let it be assumed that the discharge scale is determined, by measurement, to be 1:300,000. This indicates an error of but $3^1/_3$ per cent and is an excellent check on the assumptions previously made. Were n taken as 1:1.033 instead of unity, the check would be 100 per cent.

Future investigations will reveal, of course, definite values of the coefficient for all possible combinations of N's in model and prototype, but where the simplified discharge scale formula, Equation 6, is used primarily to facilitate the planning of the model, it will be found sufficiently accurate. When, in the reach of river to be investigated, no observations have ever been recorded and, hence, no physical determination can be made of the discharge scale by comparing corresponding discharges in the model and in nature, it becomes much more important to perfect the formula. This being by way of digression, we return to the fact that, in the hypothetical model, q has been determined to be 1:300,000.

If a dam is built in the model, it will be necessary to consider for its discharge scale the relationship $q' = ld^{3/2}$, which gives the value of approximately 1:440,000. This is too greatly at variance with the ratio 1:300,000 to establish the feasibility of transferring the model dimensions to nature by a mere application of normal factors. A different scale for length (or depth) must therefore be determined. Equating, $q = q'$; and $\frac{1}{300{,}000} = ld^{3/2}$. Retaining the value of l as $\frac{1}{720}$, $d^{3/2} = \frac{720}{300{,}000} = \frac{1}{416}$; and $d = \frac{1}{57}$, the vertical scale for the head of water flowing over the structure. Similarly, when $d = \frac{1}{72}$, $l = \frac{72}{300{,}000} = \frac{1}{510}$, the horizontal scale to be applied to the length of the structure. Thus it is found possible, even in cases where the formulas are apparently incompatible, to apply the results determined by tests.

This brief discussion does not by any means close the subjects of determining discharge scales and establishing the variations to be observed in standard discharge formulas, but on the contrary, should open up an entirely new line of thought and endeavor. Only after many hundreds of experiments have been carried out by various laboratories and all the data obtained from these various sources have been correlated, will the problem be completely and satisfactorily solved. It is too much to hope that this will happen immediately, but the time is not distant when considerably more light will be thrown on the subject. Much is to be expected, in this connection, from the new hydraulic laboratory of the Bureau of Standards in Washington, D.C.

Hundreds of formulas for flow in natural water courses have been devised, some with few, some with many, variables or coefficients. Each was based on observations made where it seemed to apply with reasonable success, and each has since been applied to other cases where its limitations were more apparent than its merits. The mass of observations and experience concentrated in these formulas should never be overlooked by the experimenter, however, for many of them are useful in designing models, in computing corrections for disturbing factors, and in interpolating between observed values.

Considering the Chezy formula and applying to it the notations herein used for similitude, there is obtained: $q = cr^{1/2}s^{1/2}a = cl^{1/2}d^2$ approximately. For an undistorted model in which $d = l$,

$$q = cl^{5/2} \qquad [8]$$

If it appears desirable to design the model so as to have in addition the relationship, $q = ld^{3/2}$; then $q = cl^{1/2}d^2 = ld^{3/2}$; or $l^{1/2} = cd^{1/2}$; or $l = c^2d$; or

$$\frac{l}{d} = c^2 \qquad [9]$$

That is, both relationships are satisfied when the reciprocal of the distortion of the vertical scale is equal, in the model and in nature, to the square of the ratio of the Chezy coefficients. An undistorted model satisfies both relationships only if this ratio c is unity, but there is of course no good reason to expect that c will be unity or any other known value unless special precautions are taken to make it so.

A similar relationship can readily be developed directly, from the Manning formula or from the Chezy coefficients as determined by the application of the Manning formula, that is, $q = n^{-1}l^{1/2}d^{13/6}$

Or, if $q = ld^{3/2}$, then $d^4 = n^6 l^3$; or

$$\frac{d}{l} = n^2\, d^{-1/3} \qquad [10]$$

It is thus seen that an undistorted model satisfies both relationships only when $l = n^6$, but that a distorted model satisfies both relationships when the distortion of the vertical scale equals the square of the ratio of the Manning roughness coefficient divided by the cube root of the depth scale.

Now, although it has been found from recorded tests that the values of Manning's n may be expected to vary in the model and in nature so as to make their ratios nearly equal through limited ranges of the basic scale, there is no good reason to expect that this will be necessarily true for every case unless special precautions are taken in preparing the bed surfaces. Rather than work on the premise that the ratio will approximate unity in all future models, it would seem preferable to determine for each model the C in Chezy's formula and the n in Manning's and Kutter's as a guide to estimates for the future. The correlation of all facts and data now available and subsequently to be obtained should make the exact determination of these ratios possible at a reasonably early date.

There is frequently a considerable difference between the n of Manning and that of Kutter, the latter exceeding the former in most reaches of the Mississippi River, although, for grossly distorted models of the river, Manning's coefficient may be much larger than Kutter's. For purposes of interpolation only, one formula is about as good as another, but for extrapolation and an extreme range of conditions, Kutter's formula seems to give closer results.

An example will illustrate some of the points just mentioned. It is proposed to prepare a stiff clay model of a considerable reach of the Mississippi River. In a typical section of the river, when the measured discharge was 1,125,000 sec-ft. the mean depth was 51.0 ft., the slope 0.044 ft. per 1,000 ft., and the mean velocity, 4.76 ft. per sec. Chezy's C was 100.4; Kutter's n was 0.037; and Manning's n was 0.028.

The model scales selected are, l = 1:4,800, d = 1:200, and a distortion equal to 24. Then the mean depth in the model is $1/200 \times 51.0 = 0.255$ ft.; and the slope equals $24 \times 0.044 = \frac{1.056 \text{ ft.}}{1{,}000 \text{ ft.}}$. Chezy's C should be $\frac{100.4}{\sqrt{24}} = 20.4$. Then the mean velocity will be $20.4 \times \sqrt{0.255 \times 0.001{,}056} = 0.335$ ft. per sec. Kutter's n will be 0.038; Manning's n will be 0.058; and $q = \sqrt{\frac{1}{24} \times \frac{1}{4{,}800} \times \frac{1}{200}} = \frac{1}{13{,}600{,}000}$. The discharge in the model will be $\frac{1{,}125{,}000}{13{,}600{,}000} = 0.0828$ sec-ft. Note that in this case Kutter's n in the model and in the river are practically the same, or their ratio, $\frac{0.038}{0.037}$, is practically unity, while the ratio of the corresponding coefficient c of Chezy is $\frac{20.4}{100.4} = \frac{1}{4.9} = 0.22 = \frac{1}{\sqrt{24}}$; and the ratio of the corresponding n of Manning is $\frac{0.058}{0.028} = 2.07$.

These scale values as here determined satisfy all the requirements previously stated: $q = ld^{3/2} = cl^{1/2}d^2 = n^{-1} l^{1/2} d^{13/6}$, when $\frac{d}{l} = \frac{1}{c^2} = n^2 d^{-1/3}$.

The velocity scale, which was mentioned briefly in passing, is also worthy of greater consideration and investigation than it has received in the past. Assuming the scale to be represented by either $\sqrt{d}$ or $\frac{r^{2/3} s^{1/2}}{n}$, the value obtained is inevitably the scale for mean velocity. If the corresponding discharges in nature and in the model are known, the computed values of v can be checked by dividing the discharge scale by the area scale, ld. But this also gives a ratio of mean velocities.

When the model is distorted, a wide, comparatively flat section in nature is changed to a narrow and rather

MODEL OF THE MISSISSIPPI BELOW CAIRO, ILL. (l = 1:4,800, d = 1:200)

Artificial Roughness in Back Areas Removed to Show Relief. Extreme Turbulence Generally Lacking in Spite of Great Scale Distortion

deep section in the model, and this change in the configuration of the cross section has a peculiar effect on the velocity scale. However smooth the model may be finished, the frictional resistance of the sides and bottom of the channel will be felt for several inches toward the center of the section. These several inches may correspond, in the 1:720 scale model previously considered, to a few hundred feet, and thus produce a condition greatly different from that which may be observed in nature, where the frictional drag of the water against the river banks will be felt only a relatively short distance out in the stream. If the main consideration is one of surface velocities, as will be the case with models involving problems of navigation, the application of the scale of mean velocity to velocities measured at the surface of the stream, midway between the banks, will indicate in nature velocities considerably higher than can ever be found there. This difficulty can be solved by plotting velocity traverses for various stages in the model to determine the exact relationship between surface, bottom, mid-depth, and mean velocities. Laying out one of these determined traverses to scale and plotting through the mean a reduced traverse corresponding to that observed in the river, where the surface velocity will vary but slightly from the mean, there will be obtained a graphical relationship between surface velocities in the model and prototype for the thread of flow considered. From this may be determined a factor to be applied to the mean velocity scale at the stage considered. Repeating this procedure for various stages, a complete curve of relationship may be drawn.

The points that have been raised in connection with scales of discharge and velocity are not intended in any sense to discourage hydraulic research, but rather to explode the idea that all is known of similitude that it is necessary to know. When it is remembered that of all scale values, those for water discharge and water velocity are comparatively the simplest, and that those for sediment and debris discharge are infinitely more complex, it will be seen that a complacent attitude is far from justified.

BUTTRESSED OVERFLOW DAM WITH INTERIOR POWER PLANT, PATAPSCO RIVER, ILLCHESTER, MD., BUILT 1906

Dual Use of Buttress Dams

Basic Economies Obtained by Building Power and Purification Units Into Storage Structures

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ASSOCIATE MEMBERS AMERICAN SOCIETY OF CIVIL ENGINEERS

CHIEF DESIGNER AND SANITARY ENGINEER, RESPECTIVELY, AMBURSEN DAM COMPANY, NEW YORK

HOUSING costs are a large item in the construction of hydro-electric power plants and therefore considerable economy can be effected by installing such units inside hollow buttress dams. When a Western city needed additional water supply, but found the cost of securing it prohibitive because a treatment plant was required in addition to a dam for impounding the water, the problem was solved by building the purification units within the hollow storage dam. In this article, Messrs. Davis and Hudson explain the basic economies that can be secured by the use of such combination structures.

RESULTS of the 1930 drought emphasized forcibly the marked insufficiency of the water storage reserves available in many parts of the country. If a repetition of the unfortunate experiences of that year is to be avoided, many communities must provide themselves with additional water supplies. In view of the strained financial conditions in most cities, the cost of supplying the additional storage may be prohibitive. Thus the need for economy has become of great importance and has stimulated a more intensive study of all types of structures. Some of the advantages of buttress dams that make them especially suitable in many instances have been emphasized by our studies.

To provide adequate storage and at the same time lower materially the cost of construction, certain advances have been made in buttress-type dams both by giving a more scientific distribution of the material in the structure and by making this material serve more than one function. A few of the principles and some of the outstanding results will be treated for the benefit of other engineers who may be faced with similar problems. Improved methods of design have led to a better understanding of the laws governing the proportioning of buttresses. As a result greater economy and greater safety have been attained in recently constructed buttress dams. In addition, the cellular spaces between the buttresses and decks make possible the attainment of even greater economy: first, by the use of this space as housing for hydro-electric power or water-purification units; and second, by utilizing the structural members of the dam to form the tanks and basins required for the water purification plant.

The most important result of the economies previously outlined is that the cost of a storage works is greatly reduced. The principles underlying these improvements in design and the beneficial results of their application to certain projects are here discussed.

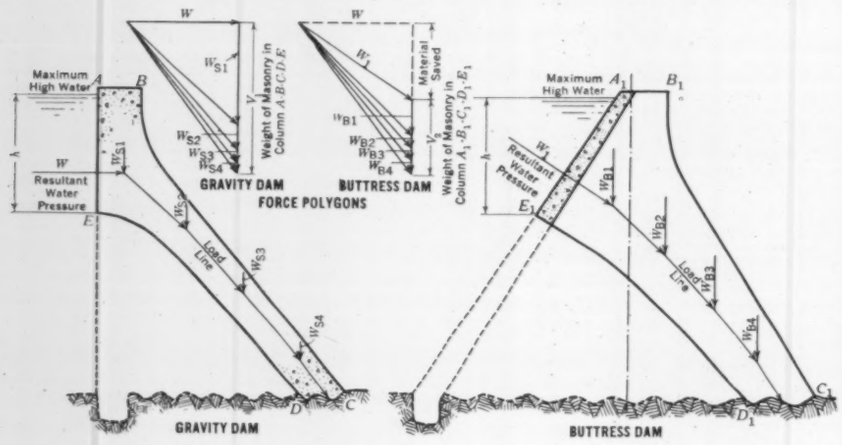

Maximum High Water
Resultant Water Pressure
Load Line
GRAVITY DAM
BUTTRESS DAM
FORCE POLYGONS
Weight of Masonry in Column A B C D E
Material Saved
Weight of Masonry in Column A1 B1 C1 D1 E1

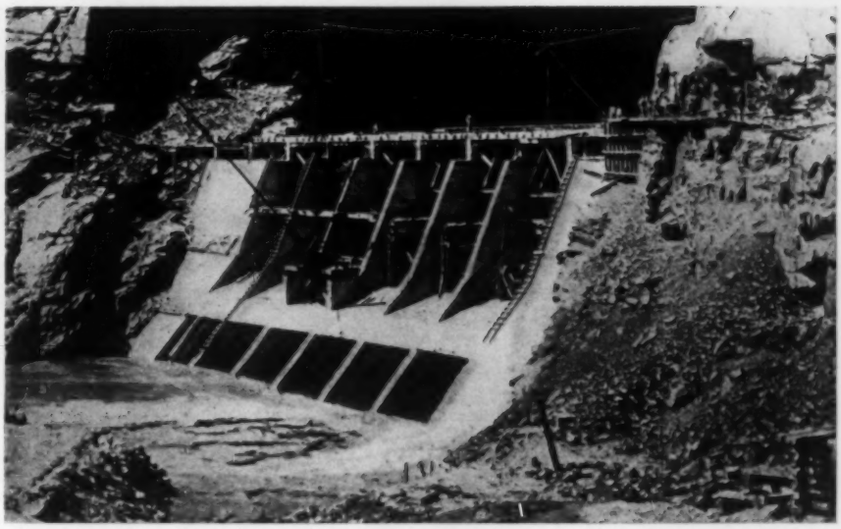
FIG. 1. COMPARISON OF LOADING ACTION IN GRAVITY AND BUTTRESS DAMS

ECONOMIC DISTRIBUTION OF MATERIAL

The principle of economic distribution of material may best be illustrated by comparing the loading action of the conventional gravity dam with that of the buttress dam. This can be done most conveniently by assuming each dam to consist of a series of curved, inclined columns, each of which is structurally independent of the adjacent columns. Such a comparison for typical columns of this type is shown in

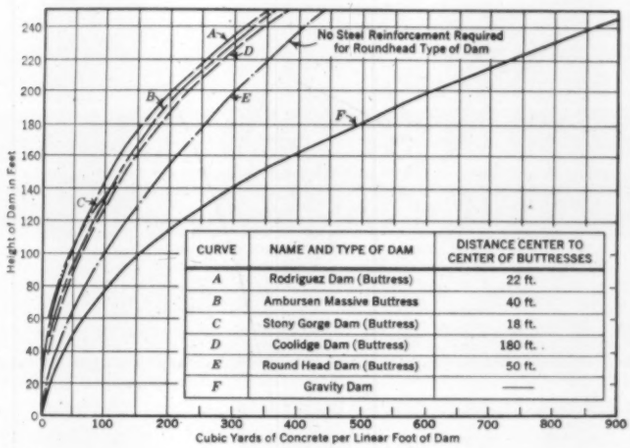
Fig. 1. The column $ABCDE$ for the gravity dam, and the column $A_1B_1C_1D_1E_1$ for the buttress dam, are each designed to transmit equal horizontal water loads, W, from the upstream face through the structure to the foundation.

It is a simple matter to determine by means of force polygons the weights of masonry—W_{S1}, W_{S2}, and W_{S3}, for the gravity dam, and W_{B1}, W_{B2}, and W_{B3}, for the buttress dam—that are required to keep each polygon in equilibrium. It will be noted that the effect of the second principal stresses acting normal to the center line of each column is neglected. In an actual design these stresses must be included. Their effect is however relatively small in most cases. For the sake of simplifying the illustration of this principle it has been neglected.



INTERIOR POWER PLANT IN A BUTTRESSED DAM NEAR SHOSHONE, WYO., 1907
Four 750-Kw. Units Installed Inside of Structure on the Big Horn River

A comparison of the force polygons shows that the total weight of masonry, V_1, required to keep the downstream column of the gravity dam in equilibrium is much greater than the total weight of masonry, V_2, required to keep the downstream column of the buttress dam in equilibrium. The reason for this is made apparent at once by a study of the diagrams. The resultant water pressure acting on the column of the buttress dam, being initially inclined, will require only a relatively small vertical masonry load to keep the resultant of all loads in the column in the position shown. On the other hand, the downstream column of the gravity dam must be relatively much heavier in order to give a resultant that has sufficient inclination to keep the column in equilibrium.

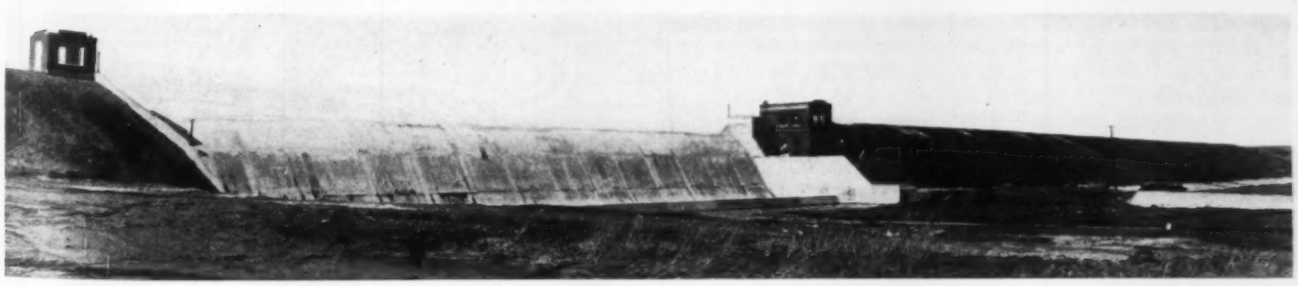


CURVE	NAME AND TYPE OF DAM	DISTANCE CENTER TO CENTER OF BUTTRESSES
A	Rodriguez Dam (Buttress)	22 ft.
B	Ambursen Massive Buttress	40 ft.
C	Stony Gorge Dam (Buttress)	18 ft.
D	Coolidge Dam (Buttress)	180 ft.
E	Round Head Dam (Buttress)	50 ft.
F	Gravity Dam	——

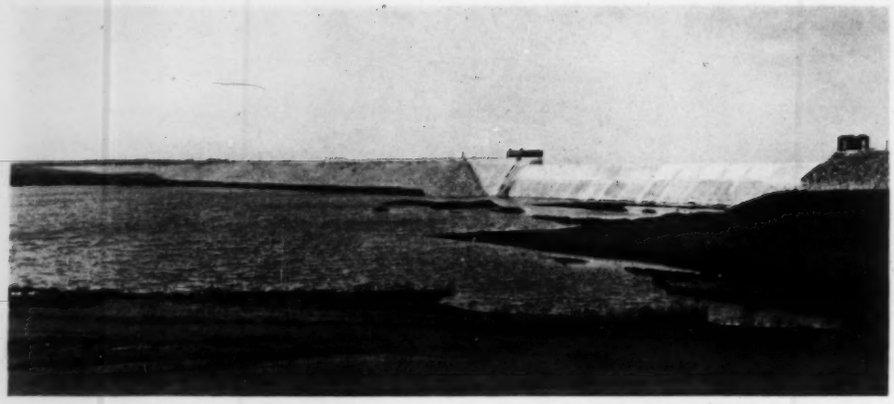
FIG. 2. COMPARISON OF QUANTITY OF MATERIALS IN DAMS OF THE GRAVITY AND BUTTRESS TYPES

The saving in masonry effected through the adoption of the buttress principle is represented by the difference between the total vertical weight of each column, or by the expression $(V_1 - V_2)$. This difference would vary with each column element, but in all cases would represent an appreciable saving in masonry. The total saving in material made possible by the application of this principle may be illustrated by comparing the quantity curves of several buttress dams with the curve of the conventional gravity dam.

These curves, given in Fig. 2, show comparative quantities of concrete for typical designs using thick masonry sections and wide buttress spacings, such as the round-head dam with buttresses spaced 50 ft. apart; the massive-buttress type dam with buttresses spaced 40 ft. apart; and the Coolidge multiple-dome dam in Arizona, with buttresses spaced 180 ft. apart. The diagram also shows curves of quantity for two well known thin-buttress dams of the Ambursen or flexible-deck type: the Rodriguez Dam, 240 ft. high, built for the Mexican Government in Lower California, which has buttresses spaced 22 ft. apart; and the Stony Gorge Dam, 140 ft. high, built for the U.S. Bureau of Reclamation, in California, with buttresses spaced 18 ft. apart. This comparison shows that dams having thick buttresses spaced relatively far apart contain a somewhat greater volume of masonry than dams of the thin-



WATER FILTRATION PLANT BUILT INTO AN OVERFLOW DAM
Constructed in 1931 for the Clinton Water Supply, Oklahoma



UPSTREAM FACE OF CLINTON DAM
Filtration House and Intake on the Left

buttress type. This increase in masonry is more than offset by the reduced cost of forms and greater ease of construction, which are characteristic of thick-buttress designs.

It will be noted that the volume of concrete in the buttress dams compared in Fig. 2 is from 30 to 40 per cent of the volume of the gravity dam shown in the same diagram. Although the relative volume of these structures is not strictly an index of cost, comparative cost estimates have shown that the actual savings effected through the adoption of the buttress principle will vary from 20 to 40 per cent of the cost of the conventional gravity dam.

It may be noted at this point that not only has great economy been effected in the buttress dams for which quantity curves are plotted in Fig. 2, but also that the safety factors of these structures have been increased as well. The vertical component of the inclined water load on the buttress column $A_1B_1C_1D_1E_1$ tends to stabilize this column against both overturning and sliding. The stabilizing effect of this vertical load on the structure as a whole gives a factor of safety of more than twice that obtained in the gravity dam.

CELLULAR SPACES UTILIZED FOR HOUSING

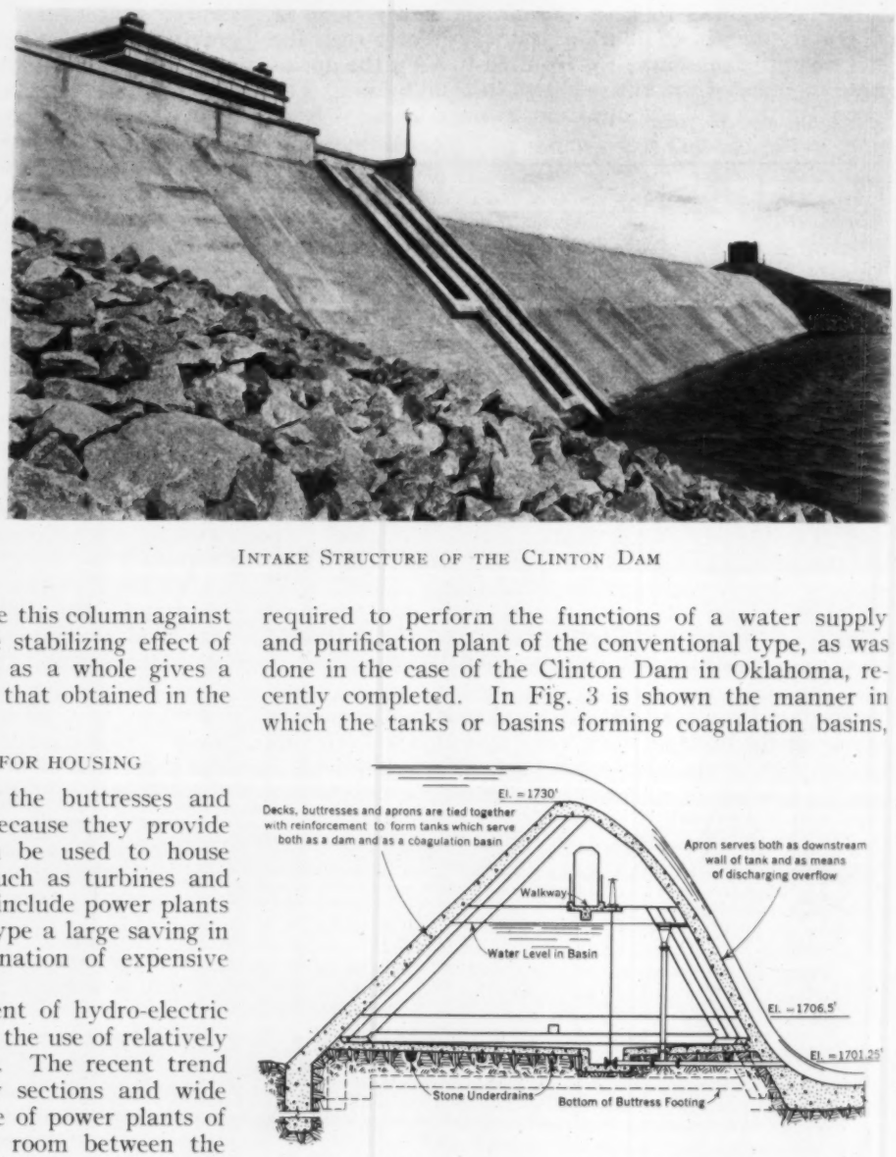
The cellular spaces formed by the buttresses and decks are structurally beneficial because they provide drainage, prevent uplift, and can be used to house hydraulic and power equipment such as turbines and generators. Two structures which include power plants are illustrated. In plants of this type a large saving in cost is effected through the elimination of expensive buildings for power houses.

One drawback to the development of hydro-electric power plants within dams has been the use of relatively narrow spacing between buttresses. The recent trend towards the use of thick masonry sections and wide spacing is advantageous for the use of power plants of this type, because there is ample room between the buttresses to accommodate modern power units. For example, the same installation of turbines, generators, and draft tubes shown in the official plans for the Hoover Dam could be placed within the cellular spaces of the massive-buttress or round-head type of dam, as both types are economical with wide spacing of buttresses.

Use of the span between the buttresses to house power units has a marked effect on the economies of combined power and irrigation projects. It is a subject worthy of extensive future investigation both in its economic and structural aspects.

STRUCTURAL MEMBERS SERVE MORE THAN ONE FUNCTION

The structural members comprising a buttress dam may be designed to serve more than one function. For example, it is possible to consolidate the dam, filter beds, coagulation basins, tanks, and other structures required to perform the functions of a water supply and purification plant of the conventional type, as was done in the case of the Clinton Dam in Oklahoma, recently completed. In Fig. 3 is shown the manner in which the tanks or basins forming coagulation basins,



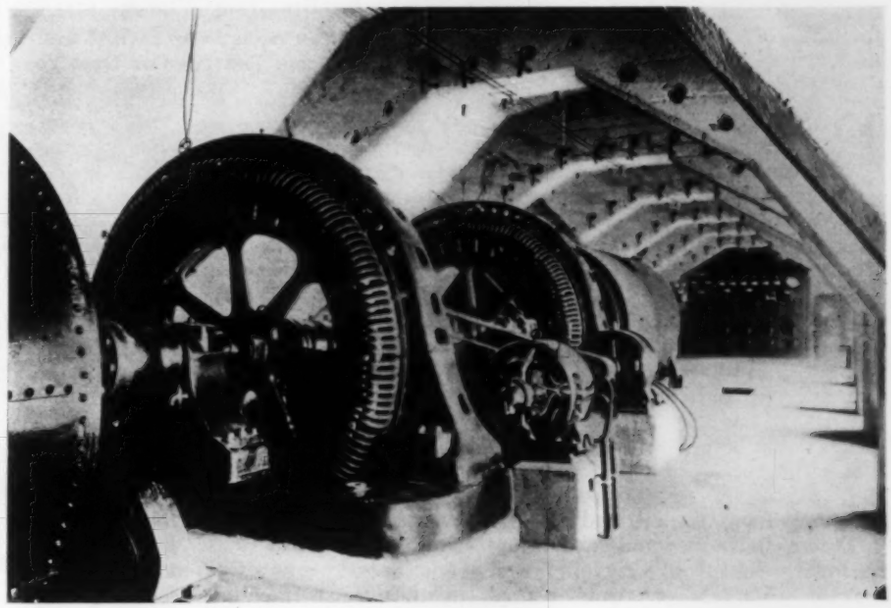
INTAKE STRUCTURE OF THE CLINTON DAM

El. = 1730'
Decks, buttresses and aprons are tied together with reinforcement to form tanks which serve both as a dam and as a coagulation basin
Apron serves both as downstream wall of tank and as means of discharging overflow
Walkway
Water Level in Basin
El. = 1706.5'
El. = 1701.25'
Stone Underdrains
Bottom of Buttress Footing

FIG. 3. SECTION THROUGH THE COAGULATING BASIN OF THE CLINTON DAM, OKLAHOMA

clear wells, and filter beds were combined to form an impounding dam with an overflow spillway. This structure has a filter capacity of 2 m.g.d. (million gallons daily) and is designed to accommodate additional filters, which will eventually increase the total capacity to 3 m.g.d. The combined filtration plant and dam, which is 380 ft. long and 32 ft. high, is flanked on both sides by earth embankments and core walls. It will be noted how conveniently this type of structure lends itself to a spillway overflow section. The downstream apron is designed to function both as a common wall for the several basins and as a slab to support the overflowing water.

The savings in the cost of storage development that may be effected by making the structural members of the dam serve more than one function can be best illustrated by comparing the economic characteristics of the conventional gravity dam and an exterior water purification plant with those of a combined structure similar to the Clinton Dam. Such a study is shown in Fig. 4, which is based on comparative estimates of both types for five similar Midwestern projects of different storage capacities. Four of these estimates are for proposed separate projects and the other one is for the Clinton Dam. The storage capacity is plotted against a cost index for the projects, including in each case the dam, filter plant, tanks and basins, buildings, real estate, and all other items required for a complete project. The wide spread between the two curves shows that, for the same cost, from 30 to 40 per cent more storage can be purchased with the combined hollow dam and interior purification plant than with a considerably lower gravity dam and exterior filter plant. These curves, which are based largely on actual bid prices, give a direct measure of the savings that result from making the material in the dam serve more than one function.



INTERIOR POWER PLANT IN THE ILLCHESTER DAM, THREE 500-HP. UNITS

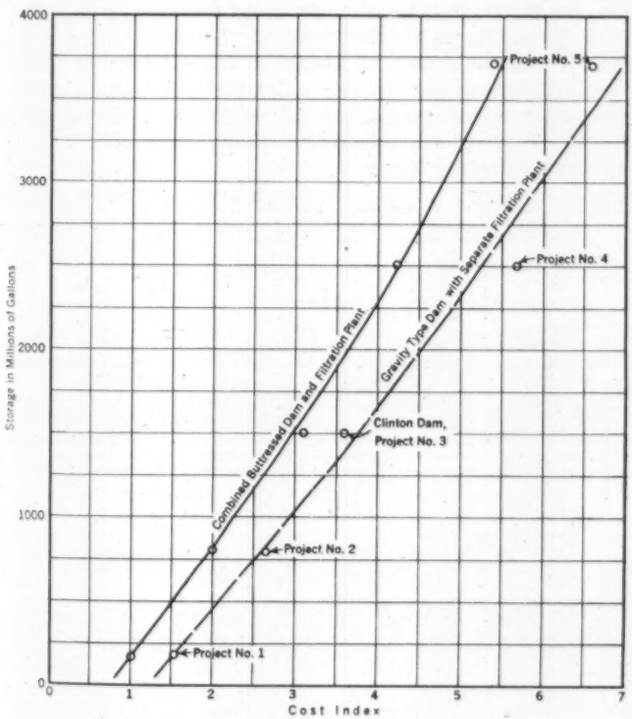


FIG. 4. COST-STORAGE CURVES FOR STORAGE DAMS WITH SEPARATE AND COMBINED FILTRATION PLANTS

Aside from the saving in construction costs and the elimination of several expensive buildings, both increased structural safety and economy in operation and maintenance may be obtained by a design of the Clinton type. All reservoir walls, as constructed according to present practice, are actually low dams. In many designs, however, adequate provision has not been made for uplift pressures under the bases of these walls, and failure by overturning or sliding has resulted. The possibility of an accumulation of pressure under the floors of the tanks is entirely eliminated by a comprehensive system of drains or trenches filled with gravel. The tying together of the various tanks to form a composite structure such as is obtained in the Clinton Dam of course greatly increases the resistance to either sliding or overturning.

Another structural element that increases the safety of the dam as a whole against sliding is the vertical weight of the water, filter materials, and equipment contained within the structure. Although this is a variable quantity, for which no allowance should be made in computations for the design, nevertheless a certain computable minimum exists and adds a substantial margin of safety to the structure.

Consolidation of the several purification structures into a single composite unit eliminates the loss of head that ordinarily occurs between the dam and the various reservoirs, and also decreases the friction losses between these reservoirs by materially decreasing the distance water travels or the length of pipe required. The elimination of lost head is one of the important benefits obtained by using this type of dam because it removes the fixed operating loss that would continue throughout the life of the structure. In a higher dam loss of head could be prevented by constructing the filter units at a certain height above the foundation of the dam.

The Port of New York

Local Conditions Govern Development of Facilities to Meet Diverse Problems

By BILLINGS WILSON

MEMBER AMERICAN SOCIETY OF CIVIL ENGINEERS
ASSISTANT GENERAL MANAGER, THE PORT OF NEW YORK AUTHORITY

OVERCOMING inherent natural difficulties is the peculiar province of the engineer, well illustrated by his success with the Port of New York. Port development is not only a question of natural facilities but of adaptation to current, ever-changing needs. As Major Wilson explains, this involves various phases of transportation—by waterway, railway, and highway. Though admirable in themselves, the waterways of New York harbor constitute a considerable physical barrier to rail and highway traffic, especially on the west. Another problem is that of trade customs growing out of long established precedent. How engineers have surmounted these difficulties is told here by one of the administrative officers of the interstate governing body of the port. Major Wilson's original paper, from which this article has been abstracted, was delivered before the Metropolitan Section of the Society on February 17, 1932.

PORT development, broadly speaking, means two things—improving existing facilities and methods of handling commerce; and so planning for the future that facilities will always be ample for the trade demands of the region, the nation, and the world. In this brief review of the Port of New York, only channels, piers, railroads, and highways will be considered, all of them preeminent among port facilities. A host of other important items will be purposely omitted, such as warehouses, drydocks, power plants, and special terminals for grain, oil, and coal.

Trade, both national and international, flows in certain well defined channels or trade routes carved out by centuries of practical experience. Attempts to run counter to trade custom can only result in financial wastage. The old economic law of supply and demand applies to port facilities, but stating it another way, trade custom "wants what it wants where it wants it."

TRADE CUSTOMS GOVERN

Bearing in mind then the practical necessity of catering to trade customs, let us briefly examine some of the factors pertinent to port development at New York. For various reasons, probably the best of which was self-defense, the earliest settlers chose to develop the tip of Manhattan Island, little realizing the vast empire that would spring up to the west of that wide and windy Hudson River. The earliest known map (1626) shows these hardy pioneers safely ensconced behind their log walls. Since communication with the Brooklyn shore was quicker and safer, that section developed faster than New Jersey; and since practically all early commercial transportation was by water, the boats served all sections with equal facility.

OLD MAP OF THE BATTERY, MANHATTAN ISLAND

The first railroads to tap the interior established connections by boat with Manhattan to compete with canal and river carriers, and thus there has grown up a so-called "free lighterage and carfloat" service, which now brings all railroads to all waterfronts, and hence to all ships, on practically equal terms. The water highways, with their tugs and lighters, fulfill at New York the function of the railroad belt lines of other ports, but with greater dispatch and lower capital costs.

As a result of this initial commercial impetus, population and industry have developed faster on the east shore of the Hudson River, although the majority of the railroads terminate on the west shore. Shipping, established before the railroads came, entrenched itself on the east bank of the river adjacent to the denser population, while the railroads that served the mainland, unable for the first 70 years of their existence to bridge or tunnel the river, preempted the west bank.

The rapid growth of population, industry, and taxable property in Manhattan and western Long Island, with the combining of these sections under a single administrative and taxing authority, has enabled the east side of the port to spend vast sums in providing attractive accommodations for vessels and thus holding them, up to the present.

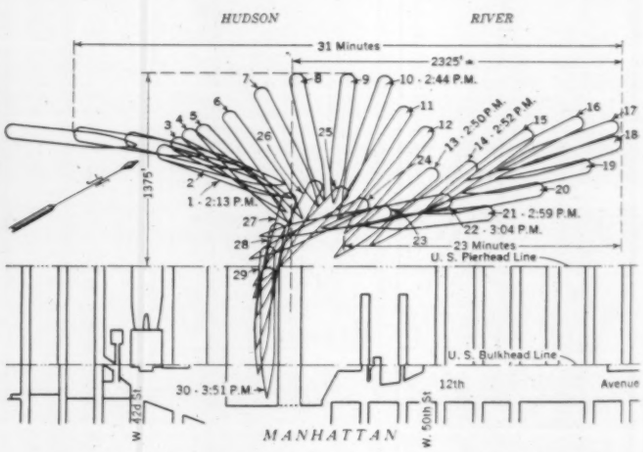
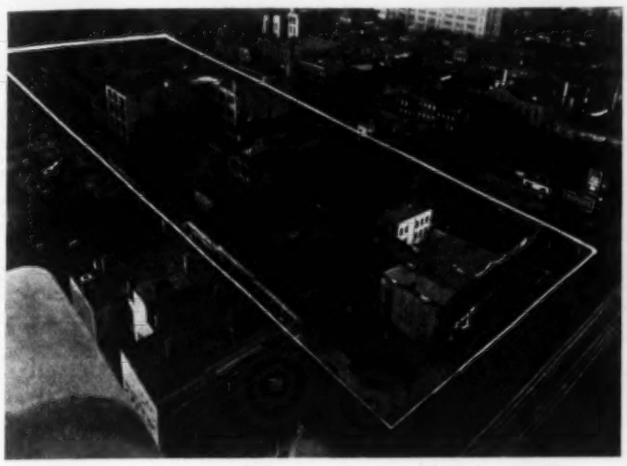
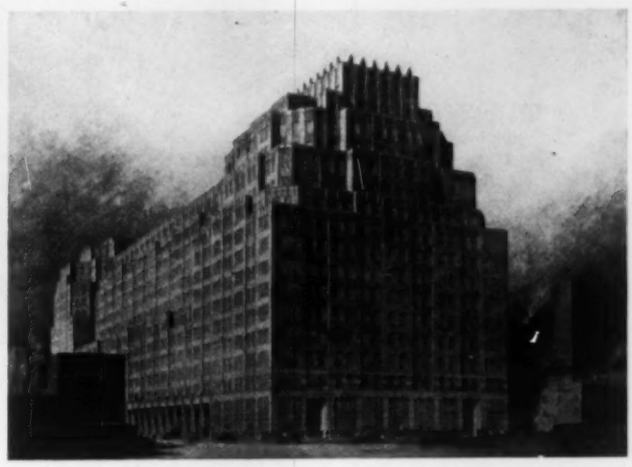


FIG. 1. DOCKING THE LEVIATHAN AGAINST WIND AND TIDE
Positions 5 to 12 and 27 to 30, Tugs Helping; Positions 15 to 22, Tugs off

Considering first the channel facilities provided and maintained by a paternal Federal Government since 1852, when the Government first started work on the New York port channels, over $68,000,000 has been expended for deepening and widening and $800,000 more each year for maintenance. Approved projects not yet completed amount to over $31,000,000 more, and will take from 10 to 15 years to complete at the present rate. The total cost to date has been about 2½ cents per ton of commerce handled—the lowest for any port on the coast.



Site Before Demolition of Old Buildings



Perspective of Structure Now Under Construction

INLAND TERMINAL NO. 1, MANHATTAN ISLAND

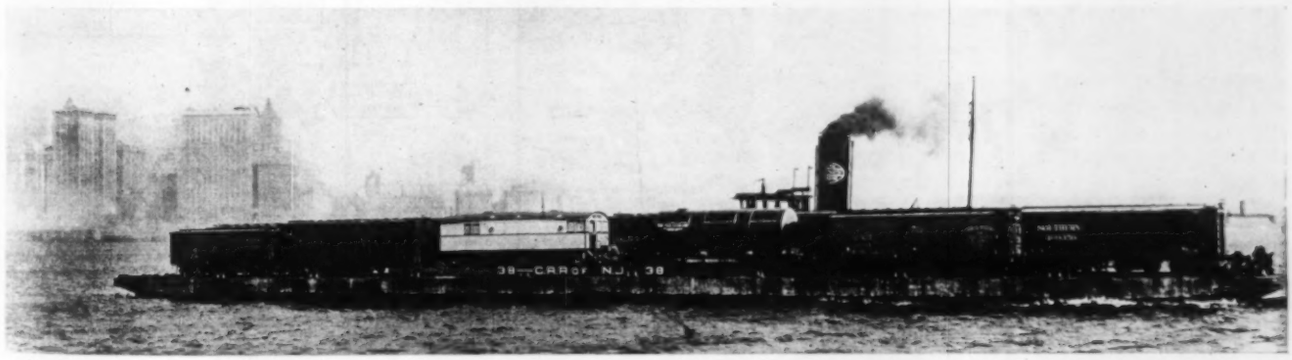
Ambrose Channel, lying between Rockaway Point and Sandy Hook, completed in 1914 at a cost of about $4,000,000, is New York's front door to the sea. It is a splendid shipway 7 miles long, 2,000 ft. wide, and 40 ft. deep at low tide, and excellently marked with buoys and lights. Inland from it extends the primary channel system of the port, principally the Hudson River, 40 ft. or more deep and capable of taking the largest ships afloat. By far the great majority of the port's commerce is carried in vessels requiring 30-ft. channels, and for these the port has a more extensive system of waterways, including the East River, Staten Island Sound, and Newark Bay. Finally, for its large fleet of harbor craft—some 6,000 boats—and for its coastwise and river vessels, the port has a yet more extensive channel system 20 or more feet in depth.

An interesting thing about New York is the large number of agencies concerned with its development. The City of New York has built most of the steamship piers; private terminal companies and railroads have built the remainder. The railroads have provided the rail terminals and such belt-line service as now exists, principally by water. The Port Authority has concentrated on improving railroad terminal facilities and interstate highway connections and protecting the port from unfriendly rate attacks by outports. Private capital has provided all the storage facilities. And last, but by no means least, the Federal Government provides, maintains, and marks the channels and anchorages.

MAINTAINING ADEQUATE CHANNELS

Because of the immense volume of traffic on all the important waterways of the port, the operation of dredges presents an interesting problem. The Corps of Engineers, U.S. Army, has met this difficulty with self-propelled, sea-going hopper dredges with capacities varying between 2,200 and 2,600 cu. yd., each costing approximately $1,000,000. These are very efficient machines, each digging and removing 125,000 to 150,000 cu. yd. of sand and silt a month at a cost of $0.115 to $0.177 per cu. yd. in the inner harbor, and of $0.08 in the Lower Bay and Ambrose Channel. These dredges operate by scraping up the spoil from the bottom with a suction rake while under slow headway, and carrying it out to sea in their own bins, for disposal.

In a busy and built-up port the proper width of the channels is always a debatable question between the navigator and the pier constructor. The answer is invariably a practical compromise—"as much of each as you can get." The interesting fact remains, however,



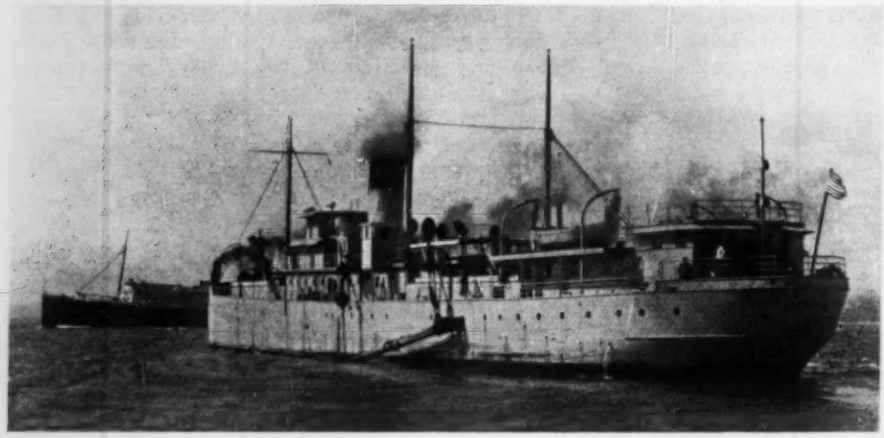
RAILROADS SUPPLY FREE LIGHTERAGE SERVICE TO ALL WATERFRONTS OF THE HARBOR

that as the length of piers is increased, a greater channel width is needed to handle properly the larger vessels that will use both channels and piers.

Note what happens when a large transatlantic liner, the *Leviathan*, 951 ft. long, is docked at Pier 86, North River, on a flood tide. The successive positions of the ship are shown in Fig. 1 at from 1 to 3-min. intervals. At her maximum outstream position she was taking up nearly 1,400 ft. of fairway beyond the New York pierhead line. Further investigations among practical navigators disclose a demand for a fairway of two 1,000-ft. lanes for large vessels transiting the Hudson River. This is the same total width as that of Ambrose Channel. Adding a 400-ft. lane along each pierhead line for local harbor craft maneuvering in and out of slips—carfloats being about 300 ft. long—gives a total desirable width between pierhead lines of 2,800 ft. Half of this, or 1,400 ft., is then available for docking a large ship with one main ship lane still open. The Port Authority has recommended, and the Corps of Engineers has adopted, 2,800 ft. as the practical minimum width for most of the lower part of the Hudson River—with more space near its mouth where traffic is heavier.

Like builders in many other fields, pier constructors are opportunists to some extent. In time of war or during bull markets, when piers are in demand or money is cheap, great improvements are planned, undertaken and, if the mood lasts long enough, completed.

History has demonstrated why the majority of steamship piers should be east of the Hudson River (Fig. 2). The port district itself generates or consumes about one-third the freight and passenger traffic in and out handled by ocean ships. Since the railroads will go to all parts of the port for the same freight rate, but trucks and taxicabs will not, the larger passenger and freight lines have tried, and will continue to try, to get berthing places as near as possible to the center of gravity of the port's commerce—off the lower west side of Manhattan Island.



OCEAN GOING HOPPER DREDGE "NAVESINK" OPERATING IN NEW YORK HARBOR

When it comes to selecting the best type of pier, we are again faced with the practical necessity of trying to design a pier to handle all kinds of traffic. New York cannot afford to go in for specialized designs like ports that have a large tonnage of limited commodities. It has no single, outstanding commodity that moves frequently in full cargo lots. Its vessel cargoes are essentially package freight, and the packages run from a 15-lb. keg of Holland herrings, or a single bunch of bananas, to boxed automobiles, heavy machinery, or a whole railroad car. For the former, ship or pier tackle is adequate and efficient, but for the latter special heavy-lift equipment must be available. This is more efficiently provided by floating units, available to all ships at their berths, than by bringing the ships to a stationary crane, or by equipping all piers with heavy cranes, which would necessarily stand idle most of the time.

Hence there has been developed for New York trade a type of shedded pier, with very narrow aprons, no railroad tracks, high cargo masts along the eaves, and with two decks where there is a prospect that a large volume of passenger traffic may be handled. This type of pier is suited to a harbor where 94 per cent of the intra-port movements to and from steamship piers are handled by trucks and lighters, and only 6 per cent by railroad cars. However, as more piers are built on the New Jersey shore, and made accessible to all rail-

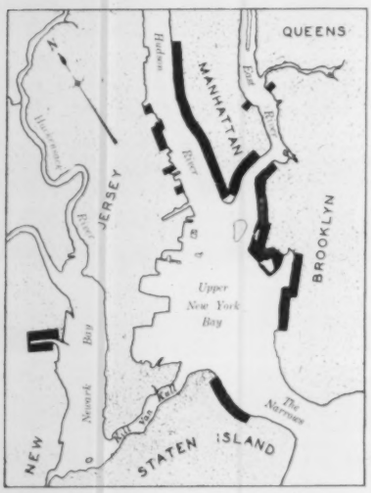


Fig. 2. Steamship Piers

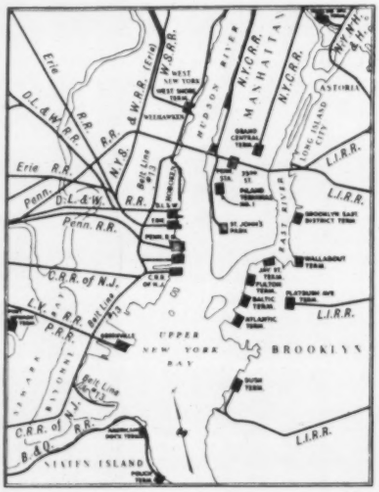


Fig. 3. Railroad Terminals

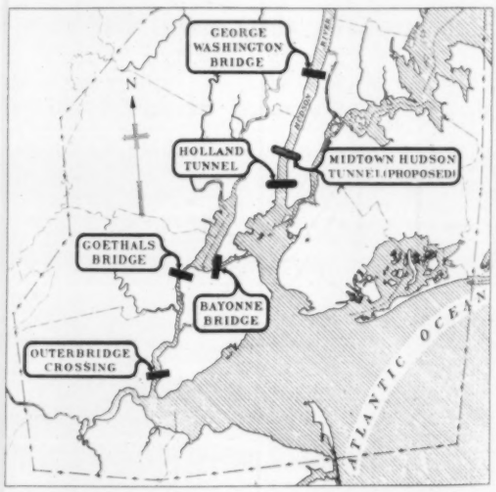


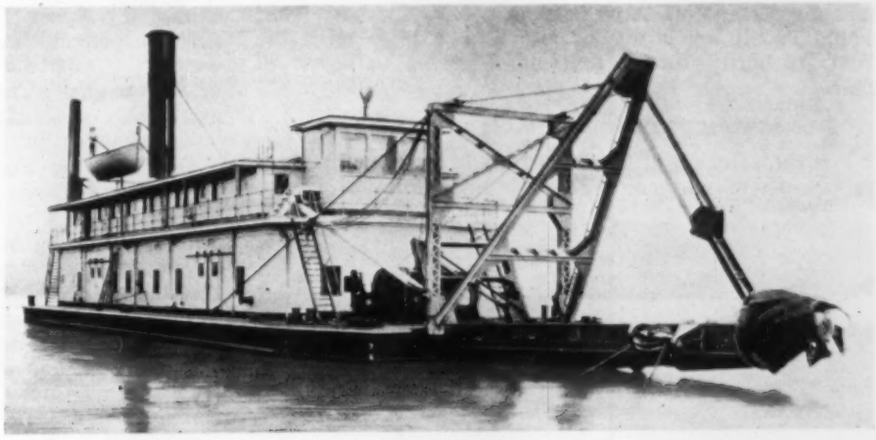
Fig. 4 Bridges and Tunnels

TRANSPORTATION FACILITIES OF THE PORT OF NEW YORK

roads through proper belt-line connections, the need for a modified design, including tracks on the piers, will become more important.

Since over 50 per cent of New York's foreign commerce moves to and from the interior, it is important that inland transportation facilities be adequately provided for in any scheme of port development, and that they be able to perform their terminal functions of interchange with ships, and collection and delivery of purely local traffic without their interfering with one another.

Ten major independent railroad systems, all highly competitive, serve the Port of New York (Fig. 3). In their natural efforts to accommodate patrons and acquire traffic they have extended their rail operations, without extra charge, throughout the waters of the harbor by a system of car floatage and lighterage unequaled for efficiency of dispatch.



STEAM DREDGE "DEWITT CLINTON," U.S. ENGINEER DEPARTMENT

Efficient as these marine operations are, something better in the way of service facilities is needed—something that will remove the purely domestic railroad traffic from the waterways and piers, releasing them for steamship use; and that, at the same time, will be independent of and not susceptible to marine risks of storm, fog, and high tides. In short, it must be an "all rail" or "rail-and-truck" terminal distribution system that can be relied on at all times to provide people with food, fuel, and building materials; and industries with raw materials and an outlet for their products, as reliable and expeditious as the service rendered competing manufacturing communities.

FIG. 5. RAILROAD PIER STATIONS AND PROPOSED INLAND FREIGHT STATIONS

RAILROADS DEVELOP PIER TERMINALS

In analyzing the general character of the traffic handled at New York by all railroads, movement will be considered first. We find by far the greatest part, amounting to about 85 per cent, originates in, or is consigned locally to, the port district. The remainder goes to ships. Taking now the domestic part only, and limiting ourselves to that which moves beyond the waterfront terminals of the carriers by carfloat, lighter, and railroad truck, we find a very substantial part—71 per cent—going to Manhattan Island.

With the exception of the New York Central Railroad, Manhattan Island has no all-rail connections. As a result, the railroads have been forced to rent, for the movement of purely local freight, 44 piers south of 59th Street (Fig. 5), which are entirely unrelated to the handling of ships. In any other city than Manhattan these 44 piers would all be freight houses or team tracks, directly on the rails of the carriers that owned them.

On the west side of Manhattan there is therefore the anomalous situation that the railroads occupy 40 per cent of the most valuable steamship frontage in the port district for the conduct of local freight operations in no way related to shipping, merely because they have no other place to go and no other way of handling their traffic.

PORT AUTHORITY DEVELOPED

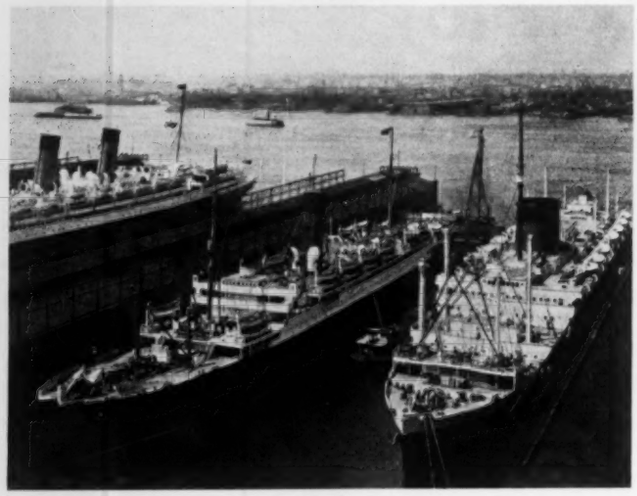
In an attempt to correct these conditions and also to plan for the future transportation needs of the railroads in all sections of the port district, the two states, New York and New Jersey, in 1921 mutually adopted a general port development plan calling for a system of railroad belt lines designed to bring all carriers to all sections of the district on equal terms. They created the Port of New York Authority to put this plan into effect.

Since progress on a railroad plan can only be made as the railroads can agree among themselves, the achievements thus far have been conservative. However, some progress is being made. Belt Line No. 13, along the New Jersey shore, is now in operation under the di-

rection of a committee of all interested lines. The tunnel connection to Brooklyn, a vital part of the plan, has been carefully studied, but further investigations are necessary in view of present business conditions, and these are under way. This tunnel cannot be undertaken by the Port Authority until the railroads that would use it are ready to negotiate a lease with the Port Authority for an amount sufficient to cover all charges.

SYSTEM OF INLAND FREIGHT TERMINALS

For the solution of the local freight problem in Manhattan, there was contemplated a program of inland



CHELSEA DOCKS AND HUDSON RIVER TRAFFIC, NEW YORK

freight stations, connected with all trunk-line railroads by deep-level electric freight tunnels. This would be very expensive, but the fundamental idea is good, that of inland freight terminals to release piers for steamship use. A solution was offered by the rapid development in the manufacture and use of motor trucks during the last decade—the substitution of motor trucks, operating via highway tunnels, bridges, and ferries, for the deep-level electric freight tunnels. Other traffic could then help carry the cost of such public tunnels and bridges. The Holland Tunnel had already been started when this revised plan was launched.

After prolonged conferences with the carriers, there was finally evolved a Manhattan freight plan consisting of three inland freight terminals (Fig. 5) for L.C.L. (less-than-carload) freight, and "store door delivery" for C.L. (carload) freight. Only one of these inland terminals would be built at the outset and all carriers would use it through a system of motor trucks operated by themselves. The flat New York freight rate would apply to the public freight station on the ground floor and the carriers would lease the ground and basement floors and operate this station themselves.

In pursuance of this arrangement the Port Authority is providing the initial terminal, of a capacity adequate for approximately one-third of the Manhattan L.C.L. freight of all the carriers. It occupies the entire city block bounded by Eighth and Ninth avenues and 15th and 16th streets, a ground area of $3\frac{1}{2}$ acres. The particular site selected was practically the only block of sufficient size including no municipal or church property within the zone approved by the railroads for the first unit. Manhattan real estate is too expensive for single-story terminal improvements and, therefore, to assist in carrying the cost of the real estate, the Port Authority is erecting a 14-story commercial loft building above the railroad terminal premises.

Lastly in the program of port development there is the matter of improved highway connections between the various insular sections of the port. There is such a vast intra-port movement of persons and goods by automotive vehicles that the facilities for crossing the waterways must be modernized to keep pace with the vehicle traffic. The Holland Tunnel, opened in 1927, was highly successful and marked the beginning of an interstate program of this character.

On the New York side of the harbor, the City of New York has been providing the local highway facilities for interstate traffic. On the New Jersey side, the New Jersey Highway Commission is carrying out in splendid fashion an elaborate plan of improved highways throughout the state.

The interstate field of highway crossings is at present the responsibility of the Port of New York Authority, pursuant to concurrent legislation of the states of New Jersey and New York. The Port Authority controls and operates five such crossings and has plans for a sixth, the Midtown Hudson Tunnel (Fig. 4).

Since all five crossings and any future ones built by the Port Authority must be paid for out of tolls, the question naturally arises, will there be enough traffic to support them all? We think there will be! On Sunday, April 12, 1931, the Holland Tunnel handled 58,7.0 vehicles. On Sunday, October 25, 1931, its opening day, the George Washington Bridge handled 56,456 vehicles in the first 19 hours, from 5:00 a.m. to midnight; and 59,615 in the first full 24 hours.

Studies made by the Port Authority indicate that under normal conditions and with adequate facilities, interstate highway traffic in the district will double itself in about nine years, or at the rate of 8 per cent per annum, compounded. Traffic on all Hudson River crossings in 1931 increased 8.5 per cent over 1930. In 1931 the five Port Authority crossings considerably more than earned their operating expenses and fixed charges.

IMPORTANCE OF FUTURE PLANNING

I firmly believe that we are only on the threshold of a tremendous highway transportation development that will revolutionize land transportation, particularly in terminal areas. Just as the railroads, with their spur tracks and sidings, proved more flexible than the canals in serving large cities, so the motor truck, penetrating every avenue, street, and alley, is directly performing services that the railroads can now provide only indirectly. We must, therefore, concern ourselves with the engineering problems that the motor-vehicle industry creates—problems of more and better highways, bridges, tunnels, and terminals.

The importance of planning the highway facilities of the port with perhaps even somewhat more care than has been used in planning its railroad improvements must be evident. The Port Authority, in undertaking to provide the interstate highway links in the Metropolitan District, is making an important contribution to port development.

Engineers engaged in all these fields of port development are contributing, equally with the financier, builder, and operator, to the continuous improvement in this port's ability to render service. It is service, after all, that is the principal function of a port, and therefore, the principal incentive of those who labor incessantly to preserve its past reputation and ensure its future progress.

Heat Losses from Sludge Digestion Tanks

Relative Radiation at Different Temperatures

By WILLEM RUDOLFS, M. AM. SOC. C.E.
and H. J. MILES, JUN. AM. SOC. C.E.
CHIEF AND RESEARCH ASSISTANT, RESPECTIVELY, DEPARTMENT OF SEWAGE RESEARCH
NEW JERSEY AGRICULTURAL EXPERIMENT STATION, NEW BRUNSWICK, N.J.

ONE of the forward steps in sewage treatment processes has been the development of sludge heating to hasten digestion. This has been accomplished generally by utilizing the gas produced in the digestive process as fuel to heat water circulating in coils. In this article Professor Rudolfs and Mr. Miles give the results of experiments made at the New Jersey Agricultural Experiment Station to determine the extent of the heat losses from tanks maintained at the temperature of most active digestion.

WITH the increasing number of heated tanks for sewage sludge digestion, the question of heat losses becomes of considerable importance. Heating sludge to between 70 and 80 deg. fahr. reduces the time required for digestion and hence increases the digestive capacity of the tanks. For the heating of such tanks, the gases produced in the processes of decomposition are generally used and have proved sufficient in most cases to supply the necessary heat. Experiments have shown that the use of higher temperatures, at which thermophilic bacteria are most active—about 120 deg. fahr.—materially reduces the period required for digestion. From a practical point of view, the question has been raised as to whether sufficient gas can be produced to maintain the tanks at the higher temperature.

In a study to determine the heat losses from digestion tanks and the methods of proper insulation, the first object was to determine by means of carefully controlled laboratory experiments how much more heat is required to maintain tanks at about 120 deg. fahr. than at ordinary digestion temperatures, 70 to 80 deg. fahr.

TEST PROCEDURE

A 1-gal. earthenware jug containing a 4-liter sample of ripe sewage sludge (4 per cent solids) was placed in a thermostat-controlled incubator and kept there overnight at 50 deg. cent. This method of heating the sludge ensured an even distribution of heat throughout the walls of the jug and its contents. The following morning the jug was removed from the incubator, shaken thoroughly, and a long stemmed thermometer inserted through a hole in the stopper. The jug was then placed in an electric refrigerator (Fig. 1), maintained at a temperature of 0 deg. cent. by thermostatic control. The jug was raised several inches from the floor of the refrigerator by a metal frame, so that it was surrounded on all sides by air. The air temperature was checked.

At 15-min. intervals the temperature of the cooling sludge was observed. This experiment was repeated by heating the sludge to different temperatures and cooling as before. Some of the results obtained are plotted in Fig. 2. It will be noticed that there is a period of pronounced lag at the beginning of each experiment during which the rate of cooling increased with the decrease in temperature. At the end of the lag, the rate of cooling decreased. This period of lag varies from about $1^1/_2$ hours at 49 deg. cent. to 3 hours at 15 deg. cent. The curves of all the experiments coincide, with the exception of the sections representing the periods of lag.

One of the chief reasons for this lag is probably that sludge is a poor conductor of heat so that the outer layers begin to cool at once but the inner layers change very little until a sufficiently large temperature gradient has been established. That sludge is a poor conductor of heat has been observed on several occasions when temperature readings were taken at different points in a tank. This is particularly noticeable when the contents of a tank are raised to a higher temperature or when a new tank is placed in operation.

LOCATION OF HEATING COILS

To place heating coils near the outside of the tank, where most of the cooling occurs, would therefore seem the best practice. But, because sludge is a poor conductor, stratification may occur. That heat stratification does occur in digestion tanks has been shown before. It may amount to as much as 7 deg. fahr. within a foot or two of the heating coils. This at once raises the question where the heating coils should be placed. Practice, apparently not based on experimental evidence, varies greatly. Heating coils, both single and spiral, have been installed a few inches from the floor, at 2, 3, 5, 6, 8, and 10 ft. above the floor; and, in one instance with which we are familiar, in the upper third of the tank. Apparently the purpose of placing the coils near the bottom has been to make use of convection currents and streaming of the sludge. It is somewhat doubtful whether such currents, if they exist, are of much value, since the sludge near the bottom of the tank is usually the best digested

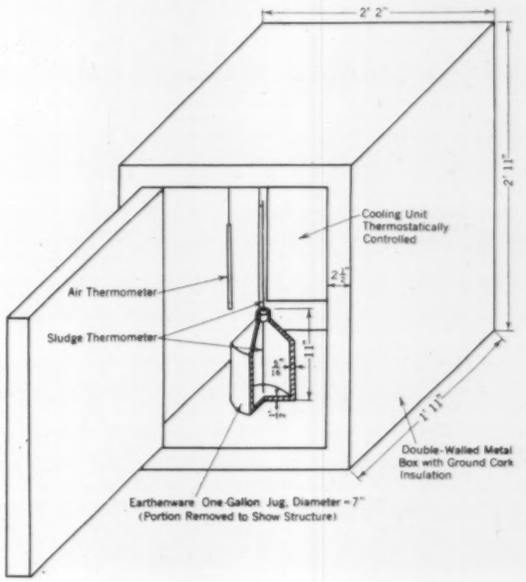


FIG. 1. APPARATUS USED IN SLUDGE-COOLING EXPERIMENT

and may require no heat to stimulate further bacterial destruction.

The second, and apparently the most important, reason for the lag of cooling is the physical characteristics of the walls of the container. We hope to conduct a series of experiments to determine the effect of different insulating materials on the heat losses from sludge filled tanks. In the preceding experiments the temperature of the sludge was always taken in the center of the jug's contents.

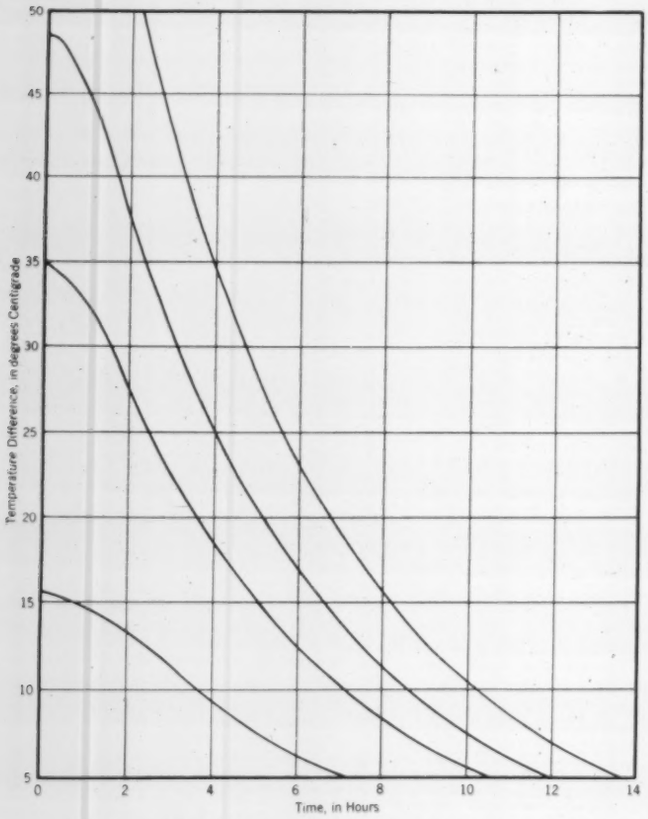


FIG. 2. COOLING CURVES OF SLUDGE SAMPLES IN JUGS
Lag Period Shown

As sludge is a very poor conductor of heat, it was decided to study the average rate of cooling of the entire sludge sample. This was accomplished in the following manner. Ten metal containers of slightly over 1-liter capacity, and equipped with tightly fitting metal covers, were partially filled with 1-liter samples of ripe sludge, containing 4 per cent solids, and placed in an incubator overnight. One of the cans, to be used as a control, was fitted with a thermometer from which the temperature of the sludge at the center could be observed. The following morning all the cans were removed from the incubator, shaken thoroughly, and placed in the electric refrigerator, which was again maintained at 0 deg. cent. The cans were placed on metal frames so that air could circulate around them. At various time intervals one of the cans was removed from the refrigerator, thoroughly shaken, the lid removed, and the temperature of the mixed sludge recorded. The can was then put aside and not used again in the experiment. In this manner the average temperature of the sludge sample in the can was determined. Simultaneous readings were made of the sludge in the control can, which was not shaken after it was placed in the refrigerator. As in the case of the previous experiments, a lag period was observed, but it was of much shorter duration.

It was thought that the lack of conductivity of the sludge might be correlated with its density. In order to determine the effect of solids concentration on the time required for cooling, the experiments were repeated using ripe sludge containing 11 per cent of solids instead of 4 per cent. No difference in the rate of cooling could be detected. The experiments were then repeated with tap water. The rate of cooling was much faster, as is shown in Fig. 3, where the results of the several sets of experiments are plotted. It would appear that the rate of cooling is not influenced by sludge concentration between 4 and 11 per cent of solids, which is the range of concentration most often found in digestion tanks. It may be assumed, however, that excessive quantities of supernatant liquor will cause greater heat losses than sludge. This means that a large quantity of supernatant liquor will require heat to raise it to the desired temperature and will lose this heat faster—another reason for preconcentrating or decanting thin sludge before placing it in a digestion tank.

It was thought possible that certain substances present in the fresh solids might be responsible for retaining the heat better than the residue left as ripe sludge. For this reason other sets of experiments were conducted on fresh sludge containing 4 per cent of fresh solids, in a manner similar to that previously described. Results showed no variation in the cooling curve obtained with either the similar or the higher concentrations of ripe sludge. It would appear, therefore, that the poor conductivity of the sludge is practically all due to the heat-resisting and heat-retaining qualities of the inert residue left as ripe sludge. Comparative studies to be made with ripe sludge as insulation material will undoubtedly show its relative value.

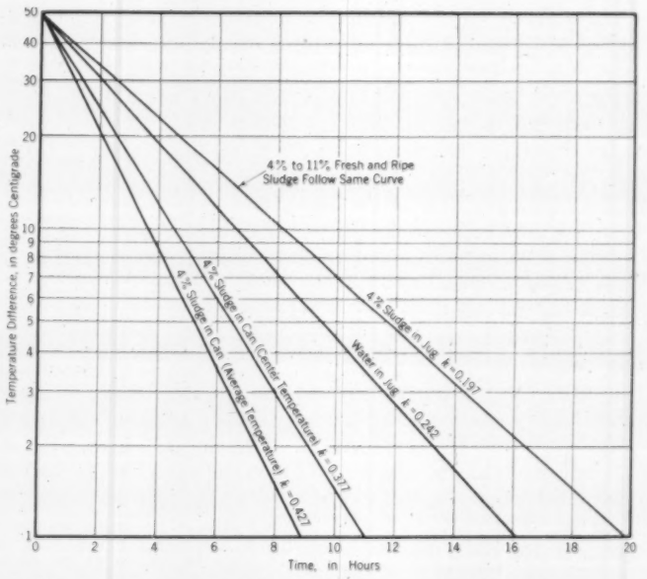

4% to 11% Fresh and Ripe Sludge Follow Same Curve
4% Sludge in Can (Center Temperature) k = -0.377
4% Sludge in Can (Average Temperature) k = -0.427
4% Sludge in Jug k = -0.197
Water in Jug k = -0.242
Temperature Difference, in degrees Centigrade
Time, in Hours

FIG. 3. COOLING CURVES OF SLUDGE AND WATER COMPARED
Solids Concentration of Sludge Does Not Affect Cooling Rate

INTERPRETATION OF RESULTS

The curves representing the results of these experiments can be expressed very closely by the formula,

$$\phi = \phi_1 e^{-kT}$$

where ϕ = difference in temperature between cooling sludge and surrounding air in degrees centigrade, at any given time

ϕ_1 = initial difference in temperature between

the hot mixture and the surrounding air in degrees centigrade

T = time, in hours, during which the mixture cools from ϕ to ϕ_1

e = Napierian base = 2.71828

k = a constant that varies with the cooling material, and the size, shape, and composition of the container

Assuming ϕ_1 as 50 deg. and differentiating with respect to time:

$$\text{Rate of cooling} = \frac{d\phi}{dT} = 50\, e^{-kT} \log_e e \frac{d(-kT)}{dT} = \frac{-50\,k}{e^{kT}}.$$

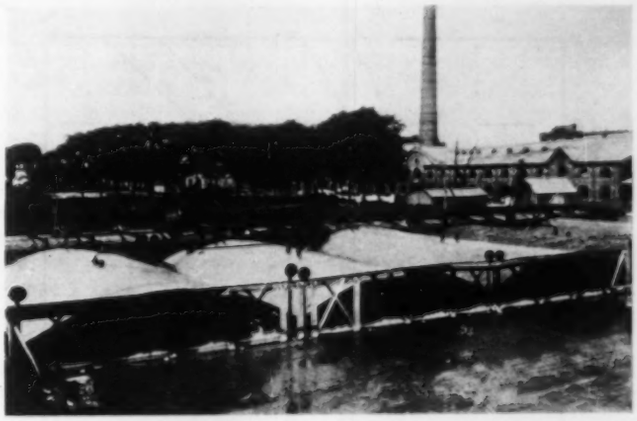
But, since $\phi = 50\, e^{-kT}$, then $e^{kT} = \frac{50}{\phi}$. Therefore, by substitution:

$$\frac{d\phi}{dT} = -k\phi \quad \ldots\ldots\ldots\ldots\ldots [1]$$

Thus it is seen that the rate of cooling varies directly as the difference in temperature between the heated material and the surrounding air. The values of k for the curves shown in Fig. 3 were computed and substituted in Equation 1. The resulting curves are plotted in Fig. 4.

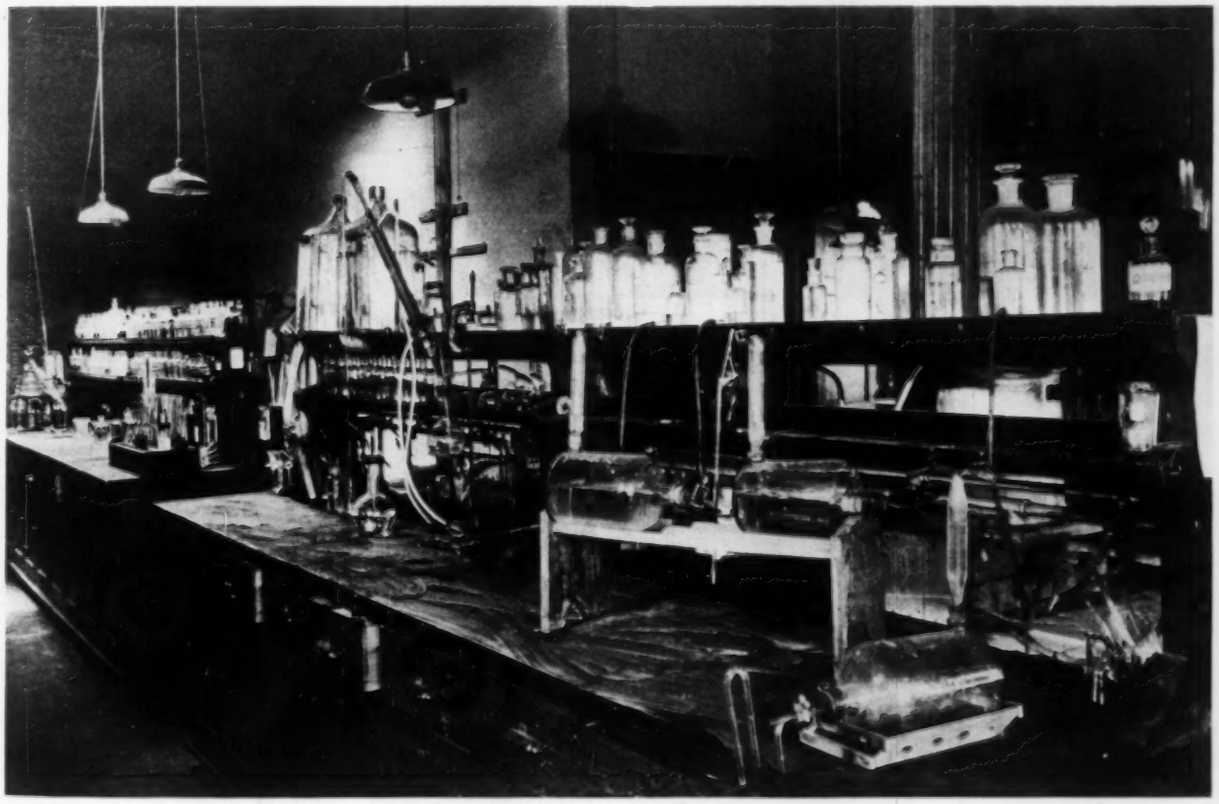
DIGESTION AT HIGH TEMPERATURES

The ratio between the amount of heat required to maintain sludge at 120 deg. fahr. and that required to maintain it at the usual digestion temperature depends on the temperature of the surrounding medium, in this case, the air. For example, when the surrounding air is at 20 deg. fahr. and the sludge is maintained at 70 deg. fahr., the rate of cooling is $k\phi = k(70 - 20) = 50\,k$ deg. per hour. When the surrounding air is at 20 deg. fahr. and the sludge at 120 deg., the rate of cooling is $k(120 - 20) = 100\,k$. Therefore, in the same tank, the ratio of the rate of cooling at 120 deg. to that at 70 deg., when the air is at 20 deg., is $\frac{100\,k}{50\,k} = 2.0$. In other words when the temperature of the surrounding air is 20 deg. fahr., twice as much heat is required to maintain a given tank at 120 deg. fahr. as at 70 deg., regardless of the size or shape of tank, thickness of walls, or insulation. The results of similar computations are given in Table I.



ONE OF THE OLDEST GAS COLLECTION PLANTS IN EXISTENCE
Built in 1909 for the Sewage Disposal Plant at Sappemeer, Holland, by Kessener

Letting p equal period of digestion, the total amount of heat lost by radiation and convection during digestion may be expressed as $p\phi k$. In any given tank the ratio of the total heat lost at any given difference (ϕ_2) in



PART OF THE LABORATORY OF THE NEW JERSEY AGRICULTURAL EXPERIMENT STATION
New Brunswick, N. J.

temperature to any other given difference (ϕ_3) in temperature is:

$$\frac{p_2\phi_2 k}{p_3\phi_3 k} = \frac{p_2\phi_2}{p_3\phi_3} \quad \ldots\ldots\ldots\ldots\ldots\ldots [2]$$

where p_2 and p_3 are the periods of digestion at the temperatures considered. Table II was computed by substituting various values of ϕ and corresponding values of p in Equation 2.

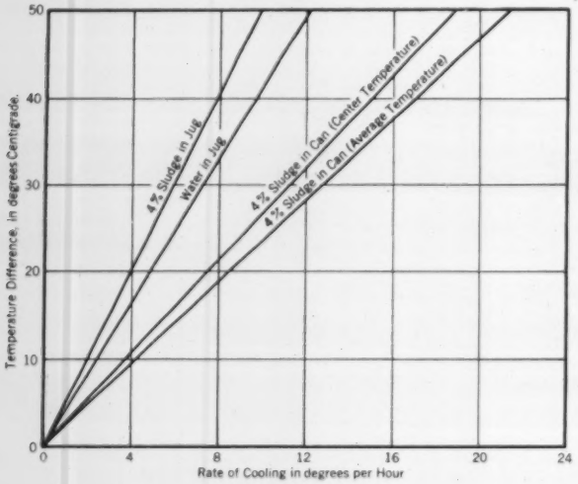


FIG. 4. CURVES OF RATE OF COOLING OF SLUDGE AND WATER

With an average air temperature of 50 deg. fahr., the rate of cooling of sludge at 120 deg. fahr. is 3.5 times as great as when the sludge is at 70 deg. fahr., and about 2.2 times as great as when it is at 82 deg. fahr. From actual experience we know that the minimum time required for digestion at 70 deg. fahr. is 40 days, or 4 times longer than the assumed maximum time for digestion at 120 deg. fahr., and that the minimum digestion time at 82 deg. is 3 times longer than the maximum digestion time at 120 deg. With carefully controlled laboratory experiments, the digestion time at 70 deg. has been reduced to between 28 and 30 days; at 82 deg. to between 18 and 19 days; and at 120 deg. to 2.2 days. Since in all cases about the same quantity of gas is produced by a given amount of fresh dry solids, it would appear that in comparison sufficient gas would be given off at the higher temperatures to maintain the desired heat in the tanks, with some gas to spare for use in raising the temperature of the colder incoming sludge either in the tank or by pre-heating. In every case the importance of sludge concentration is apparent.

The data in Table II are based on the assumption that no heat is generated by decomposition during digestion.

TABLE I. RATIO OF RATE OF COOLING AT A GIVEN TEMPERATURE TO THAT AT 70 DEG. FAHR.

Temp. of Sludge in Tank Deg. Fahr.	Temperature of Air Outside Tank in Deg. Fahr.						
	0	10	20	30	40	50	60
70	1.00	1.00	1.00	1.00	1.00	1.00	1.00
82	1.17	1.20	1.24	1.30	1.40	1.60	2.20
100	1.43	1.50	1.60	1.75	2.00	2.50	4.00
120	1.72	1.83	2.00	2.25	2.67	3.50	6.00

TABLE II. RATIOS OF TOTAL HEAT LOST DURING DIGESTION AT A GIVEN TEMPERATURE TO THAT LOST DURING DIGESTION AT 70 DEG. FAHR.

Temp. of Sludge in Tank Deg. Fahr.	Period of Digestion in Days	Temperature of Air Outside Tank in Deg. Fahr.						
		0	10	20	30	40	50	60
70	40	1.00	1.00	1.00	1.00	1.00	1.00	1.00
82	30	0.88	0.90	0.93	0.98	1.05	1.20	1.65
120	10	0.43	0.46	0.50	0.56	0.67	0.88	1.50

The derivation of Equation 1 is not original, Sir Isaac Newton having developed it as a result of his experiments on the cooling of water. To our knowledge, however, this is the first time it has been proved applicable to sludge.

MAIN POINTS SUMMARIZED

From these experiments we conclude:

1. The rate of cooling of sludge in air is directly proportional to the difference in temperature between the sludge and the surrounding air.
2. No difference between the rate of cooling of fresh solids and ripe sludge of varying concentrations between 4 and 11 per cent of solids could be detected, but there was some difference between the rates of cooling of sludge and water.
3. As the rate of cooling of sludge is less than that of water, it would appear advisable to concentrate the sludge before digestion.
4. The sludge in the center of a container cools considerably more slowly than the entire mass of sludge as a whole, but both follow the same law of cooling.

ENGINEERS DINE IN SEWAGE PUMPING PLANT

During the Annual Meeting of the Society in New York, in January 1932, one of the inspection trips took in the work under way by the Westchester County Sanitary Sewer Commission. The party were luncheon guests in the newly completed Hutchinson Project Pumping Plant of Pelham, said to be the finest plant of its kind in the world. From the outside it resembles an English cottage. The accompanying photograph was furnished by the courtesy of W. W. Young, consulting engineer of the commission.

Single-Lane Improvement for Local Roads

Light Rural Traffic May Justify Construction of One Track of High-Type Surface

By M. D. Catton

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In the past, comparatively little attention has been given to the economics of improving roads on which traffic is light. According to reports by the Highway Research Board, savings in operating costs alone make it economical to improve a dirt highway by adding a single lane of high-type construction. As shown by Mr. Catton's analysis, an average daily traffic of but 150 vehicles may be sufficient to make such an improvement economically justified even where first costs are relatively high. That the construction is adequate is shown by the fact that, if 50 vehicles per hour travel at a speed of 30 miles per hour, they will occupy the single improved traffic lane for at least 98 per cent of the distance. His method of analysis should be helpful in comparing the costs of improving various road surfaces.

EACH year highway administrators and transportation agencies are giving more attention to the economics of highway transportation. It is a broad subject, requiring careful analysis of all its elements—highway construction costs, maintenance costs, replacement costs, and use. The Committee on Highway Transportation of the Highway Research Board, National Research Council, has been giving the subject detailed study for several years, and is constantly perfecting methods of determining the annual cost of a road and the cost of vehicle operation, as well as ways of combining these two factors to determine the cost of highway transportation per vehicle mile.

In applying these methods to reach the final objective—determination of the cost of highway transportation per vehicle mile for a particular highway system—all the problems involved have not been satisfactorily solved. In the meantime, however, some of the details already worked out can be used to indicate the relative degree of improvement that may be justified on a given short stretch of highway. For example, it is possible to determine whether a high-type road would have a lower annual cost than an improved dirt road and would therefore be economically justified; or whether a two-lane concrete road would have a lower annual cost than a gravel road.

In the past, the economic comparisons generally drawn were between various types of flexible pavements and a two-lane, high-type surface for main state highways. But now that interest in local roads is growing, a new type of improvement is coming into favor. This type involves the construction of only one traffic lane with a high-type pavement, the other being left as an earth roadway, or graveled for truck traffic. This single-track road gives a high degree of efficiency and satisfaction and can justly be compared with other types built to serve light traffic and local needs.

Single-Track Pavement in Kent County, Del.
Three Counties Have Built 90 Miles of This Type of Road

Annual Road Costs Defined

The Highway Research Board has found that the average annual road cost may be expressed as "the total average yearly expenditure that will construct, replace, and maintain in perpetuity in standard serviceable condition any existing road under existing traffic and climatic conditions." This definition was expressed in the terms of a formula, as follows:

$$C = r\left[A + \frac{B}{r} + \frac{E}{(1+r)^n - 1} + \frac{E'}{(1+r)^{n'} - 1} + (\text{etc.})\right] \quad [1]$$

in which,

C = average annual road cost
r = rate of interest prevailing in current state financing
A = cost of construction
B = annual maintenance cost
E = expenditure for periodic maintenance every n years
E' = expenditure for periodic maintenance every n' years

By the use of this formula it is possible to compare the annual cost of various types of road improvement.

Costs of Vehicle Operation Decreasing

In order to determine the more economical type of road, it is also necessary to know the amount of traffic expected on the improvement and the costs of vehicle operation on each type of road. The costs of vehicle operation on various types of road have been determined by Thomas R. Agg, M. Am. Soc. C.E. The results of the tests conducted by him are contained in Bulletins

EIGHTEEN-YEAR-OLD SINGLE-TRACK PAVEMENT IN LEE COUNTY, MISSISSIPPI

69 and 91 of the Iowa Engineering Experiment Station and have also been reported by the Highway Research Board of the National Research Council. The costs of vehicle operation include gasoline, oil, tire wear, car maintenance, car depreciation, license fees, garage rent, interest on investment, and insurance.

Since these computations were made, the costs of vehicle operation have decreased. This point was brought out by Dean Agg at the eighth annual meeting of the Highway Research Board in December 1928. He made the following suggestions for differences in vehicle operating costs:

> Taking acount of . . . the various factors of tire wear, gas consumption, and similar items, the present indication is that for composite traffic, . . . the value of changing from a low-type surface to an intermediate surface (the year round—under all conditions in which that surface may be found) ranges from $\frac{3}{4}$ cent to 1 cent per vehicle mile. A similar comparison between intermediate-type surfaces and high-type surfaces indicates that the difference is likely to lie between $\frac{3}{4}$ cent and $1\frac{1}{4}$ cents per vehicle mile.

In the following tabulation are listed the savings in vehicle operating costs per vehicle mile that may be realized by a change from a lower to a higher type of road. Dirt roads are designated as *A*, ordinary gravel and water-bound macadam as *B*, bituminous treated gravel and bituminous macadam as *C*, and concrete and bituminous pavements as *D*. Both *B* and *C* are considered as intermediate-type roads.

Change in Type of Surface	Saving in Cents per Vehicle Mile
A to *B*	$0\frac{3}{4}$
A to *C*	1
A to *D*	$1\frac{1}{4}$–2
B to *D*	$1\frac{1}{4}$
C to *D*	$0\frac{3}{4}$

To be conservative and to care for further decreases that may have occurred in the cost of automobiles, gas, and other items, $1\frac{3}{4}$ cents per vehicle mile will be used as the saving in vehicle operating costs resulting from a change from type *A* roads to type *D* roads. The other data given are all conservative and closely approach vehicle operating costs today. After the annual road cost of a certain type of improvement has been determined, these data can be used to compute the traffic densities that will justify the improvement. If the actual traffic carried on the road equals or exceeds this computed traffic density, then the proposed improvement is economically justified. The amount of truck traffic on local roads will vary with the locality, and accordingly is not considered in this discussion. Since the costs of operating trucks are higher than those for automobiles, their inclusion would generally tend to lower the average daily traffic needed to pay for specific improvements.

In order to show clearly the application of these principles of highway economics, examples will be given of annual road costs for single-track concrete, for gravel, and for mixed-in-place bituminous roads. For convenience and because of the availability of the requisite data, concrete has been taken here as the illustrative material for the high-type roadway. Using comparable statistics, the principles and methods can be extended similarly to other types of pavement.

BUILDING SINGLE-TRACK PAVEMENT IN ILLINOIS
Iroquois, Vermilion, and Champaign Counties Have Completed 500 Miles

One item involved in the use of single-track concrete roads is not commonly known; this is its efficiency. In order that the efficiency of single-track concrete and two-lane roads may be equitably compared, there must be a common basis of comparison. Therefore the efficiency of the single-track type must be measured.

The Pennsylvania State Highway Department made extensive field tests to determine the distances used in passing by automobiles approaching each other from opposite directions in the same traffic lane, which were reported by the design committee of the American Road Builders Association in 1931. It was found that an automobile traveling at speeds up to about 50 miles per hour needed somewhat less than 120 ft. to turn out, pass an approaching or stationary automobile in the same traffic lane, and return. With an hourly traffic of 10 vehicles, moving at an average speed of 30 miles per hour, this means that all automobiles are using the single lane for 99.6 per cent of the distance traveled. For an hourly traffic of 50 vehicles moving at the same average speed, the single lane will be used for 98.1 per cent of the distance traveled. For average speeds of 40 miles per hour these percentages are raised to 99.7 and 98.6, respectively, because the passing distances remain the same, but the total distance traveled per unit of time is greater.

Since the single paved lane offers such a high degree of efficiency and supplies practically full-width road service for these lower traffic counts, it can be justly compared with other surfaces capable of carrying light traffic, provided the efficiency percentages previously given are used in the calculations.

PART OF A 75-MILE SINGLE-TRACK ROAD SYSTEM
Market Road No. 10, Clackamas County, Oregon

LIFE AND RESURFACING COSTS OF SINGLE-TRACK PAVEMENTS

In these comparisons, the life of single-track concrete roads will be taken as 25 years, and their replacement (resurfacing) cost as 50 per cent of the original cost. There are hundreds of miles of one and two-lane concrete roads from 15 to 20 years old in use today and they show no signs of failure. According to a statement made by C. H. Purcell, Assoc. M. Am. Soc. C.E., Chief Engineer of the California Highway Department, before the Fourteenth Annual Convention of the Good Roads League of British Columbia, at Kelowna, B.C., in October 1930, a life of more than 30 years seems probable for average concrete roads properly designed. However, the more conservative estimate of 25 years will be used here. The actual cost of resurfacing single-track concrete roads is usually less than 50 per cent of the original cost, since grading and drainage structures are included in the original construction. But again a conservative estimate (50 per cent) will be used.

OLD SINGLE-TRACK PAVEMENT IN WAYNE COUNTY, MICHIGAN
Built in 1910 and Now Widened to 20 Feet

With these facts established, it is possible to compute the annual cost of various types of road improvements. An example will serve to show how the computations are made. In applying these principles to specific projects, recent and definite construction and maintenance costs should be used.

SINGLE-TRACK CONCRETE AND EARTH COMPARED

Single-track concrete roads have been built in Maryland at a total average cost of less than $16,000 per mile, the highest costs reported. Their average annual maintenance cost is $150 per mile. A current interest rate of $4\frac{1}{2}$ per cent will be used. Making proper substitution in Formula 1, the annual road cost of this improvement is found to be as follows:

$$C = 0.045\left(\$16{,}000 + \frac{\$150}{0.045} + \frac{\$8{,}000}{(1+0.045)^{25}-1}\right) = \$1{,}049.52$$

The cost of the original earth road is the same for the proposed improvement as for the road unimproved, and these costs cancel each other. In order to determine the traffic needed to pay for this improvement by lowered vehicle operating costs it is only necessary to determine the savings made possible by the single track.

The tests to determine vehicle operating costs, previously mentioned, show that it is 1.75 cents cheaper per vehicle mile to drive on concrete the year round than it is to drive on earth. A single-track concrete road, with an efficiency of 98 per cent, will reduce this amount to 1.71 cents per vehicle mile. Dividing the annual road cost, $1,049.52, by the saving in vehicle operating cost per mile, 1.71 cents, gives 61,375, the number of vehicles that must travel over the mile of pavement in a year to bring about the required saving. Dividing this sum by 365 gives 168, the average daily traffic that will just pay for improving this earth road with single-track concrete. Any larger volume of traffic will make the improvement that much more desirable.

BANKHEAD HIGHWAY IN HUNT COUNTY, TEXAS
Has Carried Over 3,000 Vehicles per Day Into East Texas Oil Fields

In Illinois, the single-track concrete roads were built at a maximum total cost of $14,500 per mile in 1930 and have an average surface maintenance cost of less than $100 per mile per year. The same life, replacement charge, and interest rate used in the preceding example are applicable here, making the annual road cost $915.19. Dividing this amount as before gives 147, the average daily traffic that will represent a saving sufficient to cover the cost of improving the earth road. In 1932 contracts are being awarded in Illinois for similar construction for less than $10,000 per mile complete.

FORMER MAINTENANCE COSTS SHOULD BE CONSIDERED

In Bay County, Michigan, the total first cost of single-track concrete roads was $9,600 per mile in 1931, and the average annual surface maintenance cost is $50 per mile. Thus the average annual road cost is $589.71, which amount will be saved in vehicle operating expenses if there is an average daily traffic of 95 vehicles or more.

In the foregoing examples, no consideration has been given to the maintenance cost of the earth roads in use before the improvements were made. In case there was any expenditure for the maintenance of the earth roads, it should be considered and subtracted from the annual cost of the single-track concrete roads. Roughly, the annual traffic needed to pay for the improvement would be reduced by slightly less than two cars for every $10 of annual expenditure for the maintenance of the earth roads. Such maintenance costs commonly average between $100 and $200 per mile per year. Therefore the daily traffic volumes computed in the preceding examples may properly be reduced by between 16 and 32 vehicles, to 152 vehicles for the higher construction costs and to 63 vehicles for the lower construction costs.

This method can be extended to include other types of surfaces as well. In Illinois in the same area where the single-track roads previously mentioned were built, gravel roads cost an average of $6,800 per mile to build and about $220 per mile per year to maintain. A replacement charge of at least $1,000 must be made against the gravel roads every five years. If Formula 1 is applied in the manner already shown for the dirt road, it is found that, with an average daily traffic equal to or exceeding 52 vehicles, the saving in vehicle operating costs would be sufficient to cover the amount required to replace the gravel road with a single-track concrete road. In Bay County, Michigan, the cost of single-track concrete construction was paid for by maintenance savings alone in less than 10 years.

These comparisons can be made for other types of surfaces wherever they may be encountered. In cases where contracts have not been awarded recently for the types involved, detailed estimates of construction costs will be necessary before comparisons can be made.

CONCLUSIONS SUMMARIZED

It can be seen from this analysis that actual costs of construction, maintenance, and vehicle operation play a large part in determining what type of road surface is the most economical. The most economical road is not necessarily the one having the lowest construction cost. In some areas, a single-track concrete road will be preferred to gravel. When gravel is low in price and available locally it may be found the more economical type with rather light traffic in spite of higher costs of vehicle operation.

In considering the type of surface to be built it must be remembered that road improvements are justified by many factors. In some cases equitable distribution of highway funds dictates improvements; in others, there is a public demand for roads leading to playground areas; in still others, the building of a new road may be required to save time and distance. Often esthetic considerations of appearance alone dictate the surface chosen. Again, riding comfort, safety, or the necessity for structural strength may be the paramount consideration.

In addition to the saving in vehicle-operating costs, there are social advantages that should be credited to road improvements even though they cannot as easily be evaluated in dollars and cents. They contribute to better business; increased property values; greater speed, safety, and convenience in traveling; easier transportation of farm products and manufactured commodities; savings in school administration; and, more generally, to a higher standard of living.

These various factors may play a large or a small part in the decision as to the amount and kind of road improvement to be made, but the ability of a new road to pay for itself by a return to the public in the form of reduced annual road costs must always be given consideration. Calculation of this factor involves determination of the amount of traffic on the road, the cost of building and maintaining it, and the savings in cost of vehicle operation before and after improvement.

The method of analysis made possible by the work of the Highway Research Board provides a means of comparing the cost of road surfaces that is very desirable. Although it may not be perfect in application, it is certainly more accurate and dependable than any broad rule-of-thumb system.

Deflections of Swiss Dams Measured

Method Involves the Use of Triangulation with Precision Theodolites

By Fred A. Noetzli

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IN THIS article Dr. Noetzli has gathered together a set of measurements of the movement under load of Swiss dams of different types. Although the method of measuring such deflections by triangulation is not new, the extreme accuracy attained reflects great credit on the Swiss federal engineers who conducted the work. Results show that each of the dams so measured underwent a small but permanent deflection downstream due to load. In the case of a straight gravity dam, there was, in addition to the deflection, an apparent movement at its point of contact with the foundation. Dr. Noetzli suggests that all important dams be subjected to periodic measurements such as those here described so that any impending failure may be anticipated and the necessary protective measures taken.

DURING recent years measurements of deflection by triangulation have been made with marked success on several gravity, arch, and multiple arch dams in Switzerland. A complete description of the work is given in *Deformationsmessungen an Staumauern* by W. Lang, Engineer, Service Topographic Fédéral, Berne, Switzerland. A surprisingly high degree of precision was obtained in the observations, the mean error of each line of sight being usually less than 1 sec. of arc. Linear deflections of the dams were determined by intersection with an accuracy of between 0.01 and 0.02 in. The initial readings were taken as soon as practicable after the dams were completed, and readings were taken again when the reservoirs were full. After several years the measurements were repeated with the water levels at the same elevations as at the time of the previous readings. A comparison between the results showed the startling fact that all the dams investigated, straight gravity dams as well as structures of the arch type, showed permanent deformations of considerable size. On some dams at least, there were definite indications of a downstream movement continuing over a period of several years.

For some of the dams, vertical movement as well as horizontal deflection was determined both by vertical angular measurements and by leveling along the crest. Contrary to expectation, it was found that vertical movements were practically independent of water pressure and of the effect of watersoaking on the concrete, and seemed to result entirely from changes in the temperature of the dams.

MEASURING DEFLECTIONS

Deflections in dams are usually very small in spite of the enormous loads to which these structures are subjected. For instance, in arch dams several hundred feet high, the maximum deflection near the top due to full water pressure will seldom exceed 1 in. At lower elevations the movement is correspondingly less. In gravity dams the deflections are of course still smaller. The accurate determination of deflection in dams of the straight or curved gravity type and in arch dams has therefore taxed the ingenuity of investigators. Triangulation measurements and alignment observations with ordinary transits are not accurate enough, especially in the case of high dams where the lines of sight are steep.

On the Stevenson Creek Test Dam and some other arch dams, the deflections in vertical planes were measured with a clinometer of special construction, such as is described on page 75 of the Report of the Committee on Arch Dam Investigation, published in the Proceedings of the Society, Part III, in May 1928. This method, while very accurate, is rather tedious and requires scaffolding for the observer. Furthermore, clinometer measurements give no indication as to the movement of a dam at its base, which may be due to deformations of the bedrock or to other causes.

Through the ingenuity of the engineers of the Swiss Federal Geodetic Survey, a method of taking deflection measurements on dams by triangulation has been developed which has proved to be surprisingly accurate. It was first proposed and used successfully by H. Zoelly, Chief of the Division of Geodesy. The secret of the success of this method lies primarily in a rather elaborate triangulation system, by which can be determined not only the deflections of the dam and movements of the foundation rock but also displacement of the observation piers, both as to amount and direction. The instrument used for these observations must be a high precision theodolite equipped with microscopes for reading the angles to a fraction of second of arc.

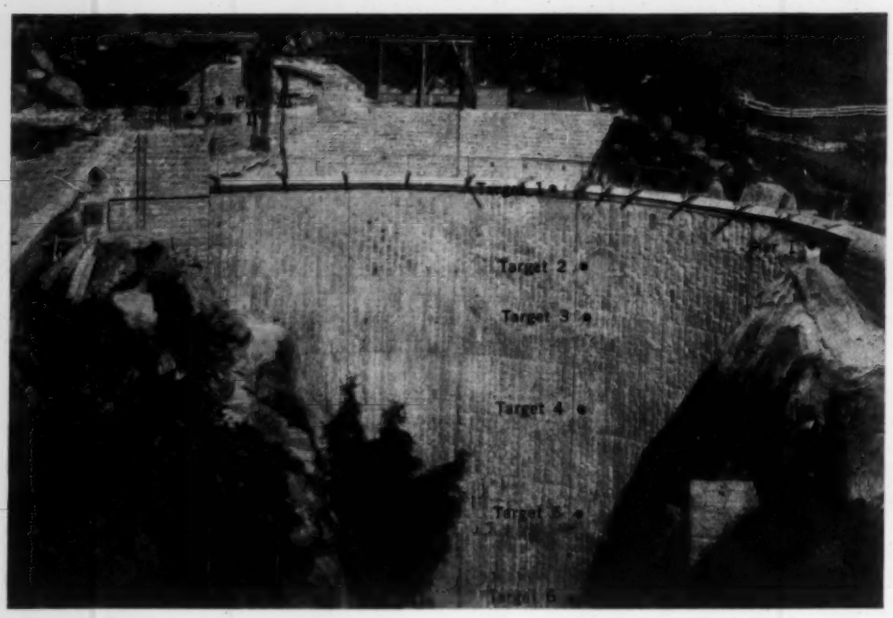
AMSTEG DAM SHOWS PERMANENT DEFLECTION

The Amsteg Dam is a very slender arch dam built entirely of cut granite with joints of cement mortar about $^1/_2$ in. thick, on bedrock of solid granite. It was constructed in 1921 to divert the water of the River Reuss into a pressure tunnel serving a hydro-electric power plant of the Swiss Federal Railways. One of the accompanying illustrations shows the dam and the location of the targets and observation piers. A description of the dam and of the deflection measurements made when the reservoir was filled for the first time, in July 1922, was prepared by me and published in the September 1923 issue of *Water Works*, Chicago.

The dam, which is of the variable-radius arch type, is about 107 ft. high, 3.3 ft. thick at the crest, and 11.5 ft. thick at the base. The upstream radius varies from 66 ft. at the crest to 46 ft. at the base. The maximum cross section is shown in Fig. 1*a*. Six targets were set on the downstream face in a vertical plane through the arch crowns. The movement of the targets due to changes of water level in the reservoir was determined by intersection from two observation piers. As the reservoir has a relatively small capacity, it could be filled in one day.

Initial measurements taken at the time the reservoir was first filled, in July 1922, furnished the deflection lines shown in Fig. 1*b*. A new set of readings, taken in April 1928, gave deflection lines shown in Fig. 1*c*. The smoothness of the curves illustrates the great accuracy of the measurements as well as the elastic behavior of the dam.

A comparison of the two sets of deflection curves indicates that between 1922 and 1928 the dam moved slightly downstream, the maximum permanent deformation at the crown of the arch being about 0.12 in. In several additional measurements were recorded during the years following. It soon became evident that the whole dam was moving bodily downstream by small but readily measurable amounts.



AMSTEG ARCH DAM AND TRIANGULATION STATIONS
Observation Targets on Face of Structure

The axonometric diagram, Fig. 2*c*, shows the total movement of the dam between April 1925, when the water level was 37.5 ft. below the crest, and October 1928, when the level was 11 ft. below the crest. The deflection curves of this diagram indicate a relatively large movement along the foundation of the dam. It is not known whether this movement took place in the area of contact between the dam and the bedrock or whether there occurred a slight slippage within the bedrock itself. According to the latest measurements, the movement has not yet stopped. Thus far it amounts to about 0.2 in. at the left abutment and roughly half this amount on the opposite side. At the base of the highest section of the dam the movement is about $^1/_8$ in. The observations are being repeated at frequent intervals.

It is of importance to note in this connection, that, as mentioned previously, the Rempen Dam is of the straight gravity type. Arch action is therefore not involved in this case.

Fig. 1*d* are shown the deflection lines for the dam when the reservoir was nearly empty, and in Fig. 1*e*, those when the reservoir was full in 1922 and 1928. A comparison of the measurements in these two years gives the permanent deflection of the dam. It is not known whether this permanent deflection is due to the deformation of the bedrock or that of the dam itself. Of interest is the observation that during the six years between 1922 and 1928, when the two sets of measurements were taken, the dam apparently became stiffer. Thus, in 1922 the maximum deflection between no load and full load was about 0.14 in. (Fig. 1*b*), but in 1928 it was only 0.11 in. (Fig. 1*c*).

REMPEN DAM MOVES DOWNSTREAM

The Rempen Dam, a straight gravity structure about 93 ft. high and 330 ft. long, was built in 1923 and 1924. The dam, which rests on a foundation of shale, was designed for 80 per cent uplift. In Figs. 2*a* and 2*b* are shown the maximum cross section and the corresponding deflection line for full reservoir. A view of the downstream face is shown in one of the photographs.

The initial readings were taken in April 1925, and

PERMANENT DEFLECTION IN SCHRAEH DAM

A few miles above the Rempen Dam, on the same stream, is located the Schraeh Dam, also known as the

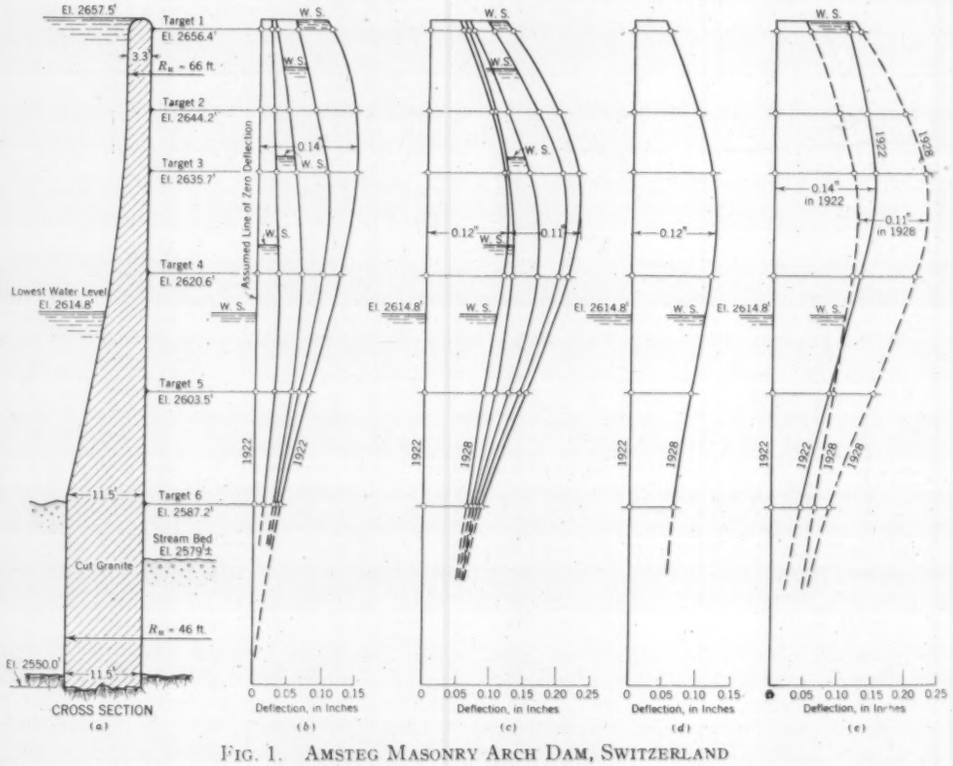


FIG. 1. AMSTEG MASONRY ARCH DAM, SWITZERLAND

(*a*) Cross Section (*b*) Deflections, July 1922 (*c*) Deflections, April 1928 (*d*) Permanent Deflection, 1922 to 1928 (*e*) Difference in Deflection with Full Reservoir in 1922 and 1928

Waeggital Dam. Both structures were built in connection with a hydro-electric development serving the city of Zurich and surrounding territory. The Schraeh Dam is a straight gravity structure 362.5 ft. high above the deepest point of the foundation. It has a thickness of about (83 per cent) of its height, except at the deepest point, where the canyon is very narrow. An illustration shows a view of the dam; Fig. 3*b* gives its maximum cross section; and in Fig. 3*c* its deflections are plotted axonometrically.

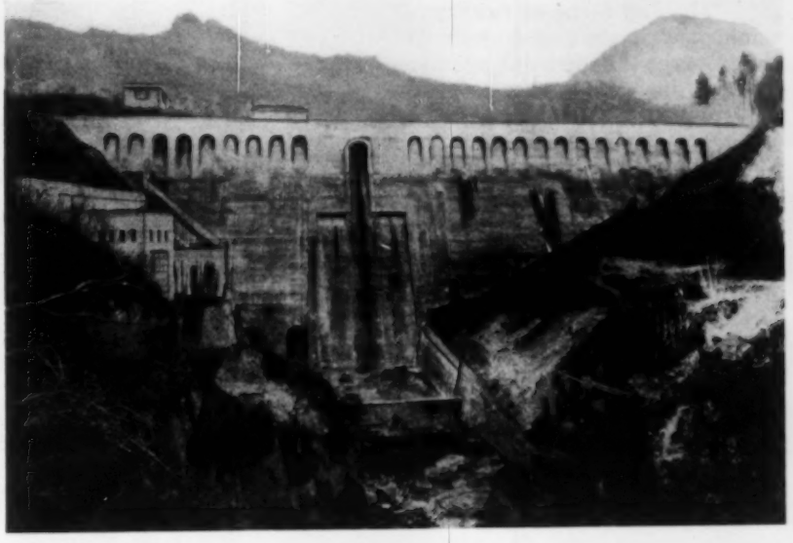
The initial readings or zero deflections were taken in May 1925, when the water level was about 131 ft. below the crest. In October 1926, when the water level was at the crest, the dam was deflected about 0.56 in. By October 1928, it showed a deflection under full reservoir pressure of approximately 0.59 in., that is, 0.03 in. more than two years previously when the water level was at the same elevation. By March 1929 the reservoir level had dropped 131 ft. below the crest to the same elevation at which the zero readings had been taken in May 1925. Nevertheless, the dam did not return to its original position but moved back at the crest only about 0.08 in. and correspondingly small amounts at other points. These data indicate a permanent movement downstream of about 0.51 in. at the crest in the middle of the dam.

In the Schraeh Dam the permanent deformations seem to have taken place almost entirely in the concrete of the dam itself. There is no indication of a movement between dam and bedrock such as was observed at the Rempen Dam. The fact that the deflection lines are smooth and regular seems to indicate that no particular irregularities in the concrete, such as cracks, are responsible for the permanent inelastic deformations.

In the course of the observations, the control measurements showed that two of the instrument piers, although founded on solid rock at a considerable distance from the dam, had each moved about 0.03 in. In the computation of the deflections, proper corrections were made for the influence of the movement of these piers. This serves as an indication of the extraordinarily high degree of accuracy secured both in taking the observations and in computing the deflections.

DISLOCATION IN LA JOGNE DAM

Built in 1920 and 1921 for a hydro-electric power development in northwestern Switzerland, the Jogne Dam is an arch dam of the variable-radius type, designed for combined cantilever and arch action under the assumption of nine vertical cantilevers and four horizontal arches. In comparing the deflections of the dam as determined in the course of several years, it was apparent that either one of the observation piers or one of the abutments of the arch had moved appreciably, the dislocation being estimated at about $^3/_8$ in. Although this movement made it impossible to draw definite conclusions regarding the behavior of the dam, the experience was nevertheless of great value because it indicated the necessity of a most careful layout of the triangulation system and adequate construction of the instrument piers.



REMPEN DAM, SWITZERLAND

MEASUREMENTS ON LES MARÉCOTTES MULTIPLE ARCH DAM

Les Marécottes, a multiple arch dam constructed entirely of gunite, is located in the western part of Switzerland at an altitude of 3,600 ft. above sea level. It is about 35 ft. high and comprises 42 arches, each 15 ft. long in span, $4^1/_2$ in. thick at the base, and $3^1/_4$ in. thick at the crest. The buttresses have a uniform thickness of 10 in. from top to bottom. For the purpose of taking deflection measurements, one instrument pier was erected, targets were placed at the top of three buttresses, and five additional targets were fixed along the crest of one arch. A photograph taken along the dam shows the location of the targets.

It was anticipated that the measurement of deflections

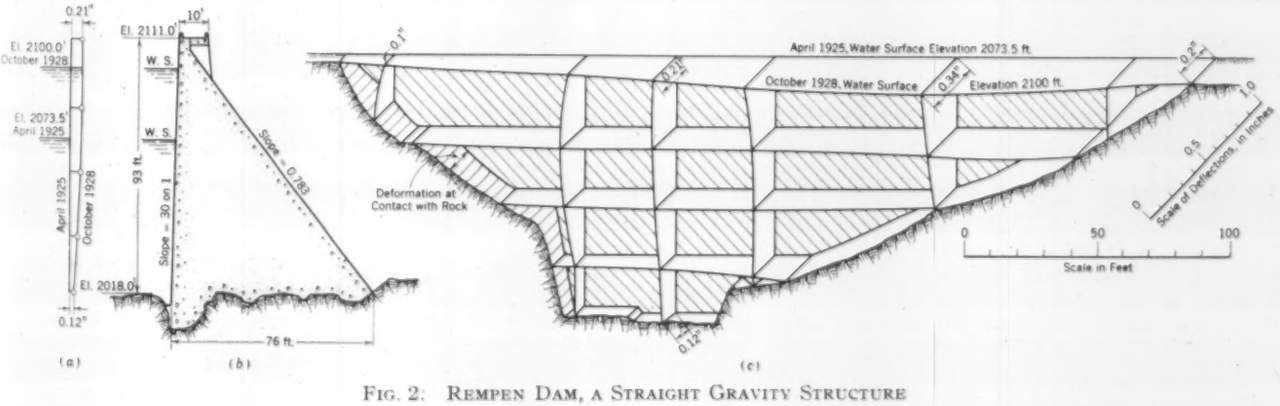


FIG. 2. REMPEN DAM, A STRAIGHT GRAVITY STRUCTURE

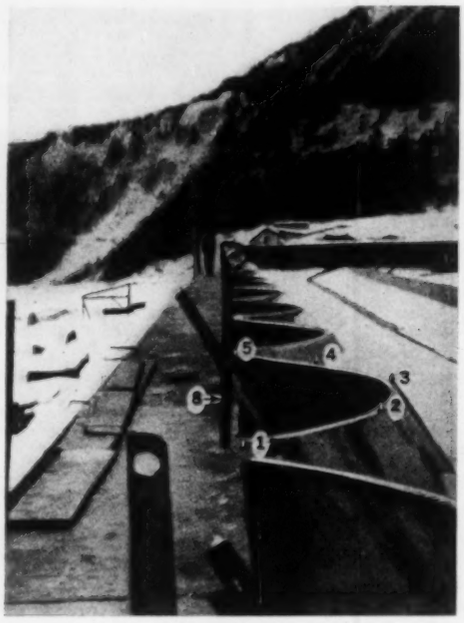
(*a*) Deflection for Full Reservoir (*b*) Maximum Cross Section (*c*) Axonometric Diagram of Deflections and Permanent Movement

in an arch of such a short span would be a severe test of the accuracy of the trigonometric method. Yet the directions were measured with an average error of 0.28 sec. of arc, corresponding to an average error in the measurement of the points on the arch of ±0.004 in. Measurements of deflection on this dam gave the following results:

1. The first filling of the reservoir deflected the three observed buttresses at the top by an average of 0.047 in. When the reservoir was emptied, the top of these buttresses moved back upstream 0.008 in. so that there remained a permanent downstream deflection of 0.039 in.

2. By the filling of the reservoir, the crest of the arch barrel investigated was deflected about 0.012 in. at the crown.

3. The influence of the variation of the temperature of the air was clearly noticeable on the days when the measurements were taken—December 15 to 17, 1926—although this variation was only about 10 deg. fahr.



LES MARÉCOTTES DAM, SWITZERLAND

VERTICAL MOVEMENTS OF DAMS

The vertical movement of several of the dams, due to water pressure, settling of the foundation, changes of temperature, swelling, and other causes, was determined in two ways: first, by measuring the vertical angles between observation piers and targets on the dam; and second, by taking levels of high precision. With a theodolite, an accuracy of ±0.04 in. vertically was obtained by the triangulation method when the line of sight was not over 200 ft. long. An engineer's level of high precision permitted the determination of the change of the vertical position of points along the crests of the Rempen and Schraeh dams with a mean error of about ±0.005 in.

From the measurements on the Rempen Dam it was concluded that changes in the water level of the reservoir produced practically no vertical displacement of any point on the dam. In 1924, that is, shortly after the dam was completed, the loss of the chemical heat of the concrete apparently brought about a small amount of settling of the points along the crest. Subsequently, the seasonal change of temperature was the dominating factor.

From 1924 to 1928 the points at the crest settled slightly less than 0.08 in. and at the same time those at the elevation of the stream bed settled approximately the same amount, which indicates that practically the whole settlement took place at or in the foundation. In this connection it is of interest to recall the large horizontal displacement of this dam in relation to its foundation, as indicated by the deflection lines shown in Fig. 2*b*.

In the 360-ft. Schraeh Dam the precise elevation of six pairs of points along the crest and three points on the downstream side at the elevation of the stream bed was determined. To ensure accuracy, three bench marks were set into the solid rock on each side of the dam. After the completion of the dam in 1925, levels were taken about once a year until 1929. In the course of these four years there was observed a gradual vertical movement which was quite independent of the level of the water in the reservoir. In the middle of the dam the settlement was about 0.14 in. at the crest and 0.08 in. at the elevation of the stream bed.

METHOD APPLICABLE TO ALL DAMS

The surprising accuracy of deflection measurements by triangulation and the many other advantages of this method suggest that it should be used for periodical observations on all important dams. The use of this method is being studied with regard to the Hoover Dam.

It is probable that occasional measurements on the St. Francis Dam by the triangulation method would have revealed its dangerous condition well in advance of its failure. It is known that cracks of considerable size developed a number of months before the collapse. These cracks were caulked to prevent leakage, but an accurate determination of any increasing dislocation of the dam and its abutments might have given a timely warning that the water level in the reservoir should be immediately lowered.

It is suggested that state authorities in charge of dams adopt the policy of having every important dam in the state observed by the triangulation method at least once a year. In the case of an earthquake or other

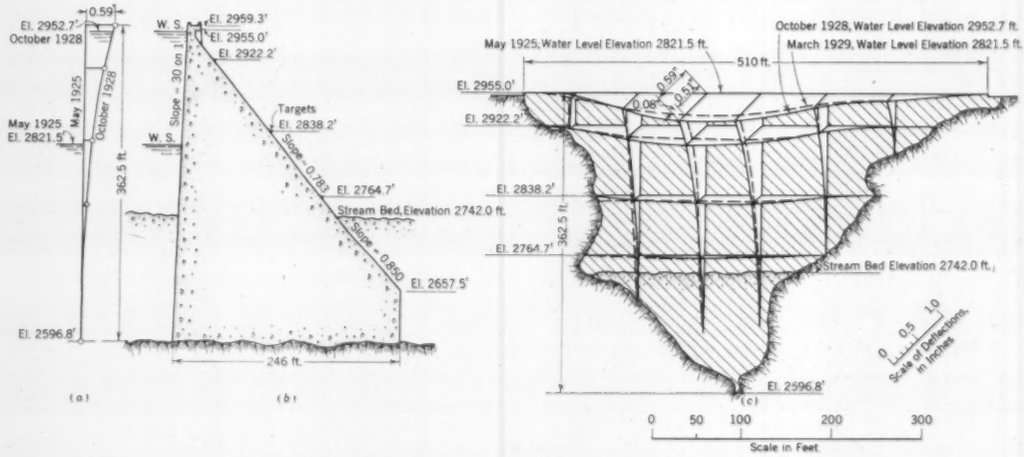
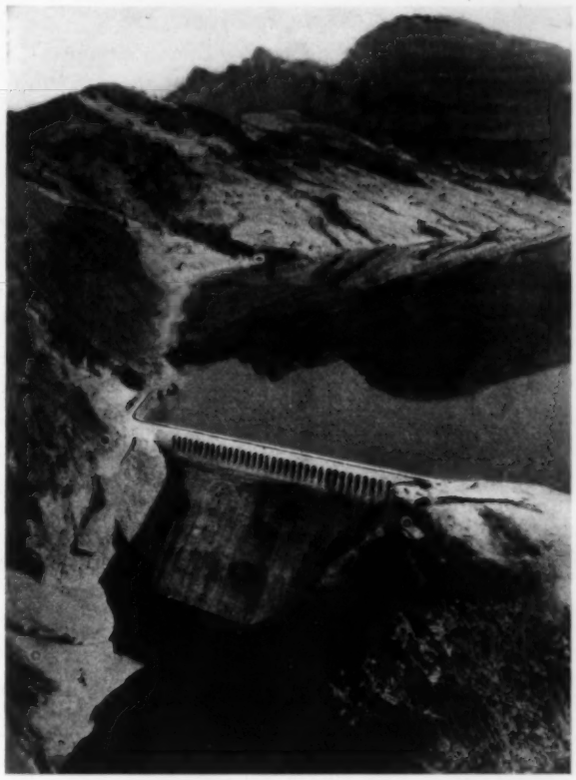


FIG. 3. SCHRAEH DAM SHOWS PERMANENT DEFLECTION
(*a*) Deflection Under Full Load (*b*) Maximum Cross Section (*c*) Deflections and Partial Recovery

disturbance, such measurements would be invaluable in judging to what extent, if any, the stability and safety of dams located in the region had been affected.

One of the most startling results of the investigations in Switzerland is the definite proof that certain dams are subject to a continuous downstream movement extending over several years. The Rempen and Schraeh dams are of the gravity type, straight in plan. Presumably there would have been a similar tendency to displacement had the dams been curved. In the case of a straight gravity dam, no possible benefit can be derived from a downstream movement, but in a curved dam the contraction joints would tend to close, thereby improving the arch action and greatly increasing the factor of safety of the structure.



GRAVITY STRUCTURE SHOWS PERMANENT DEFLECTION
Schraeh Dam, Switzerland

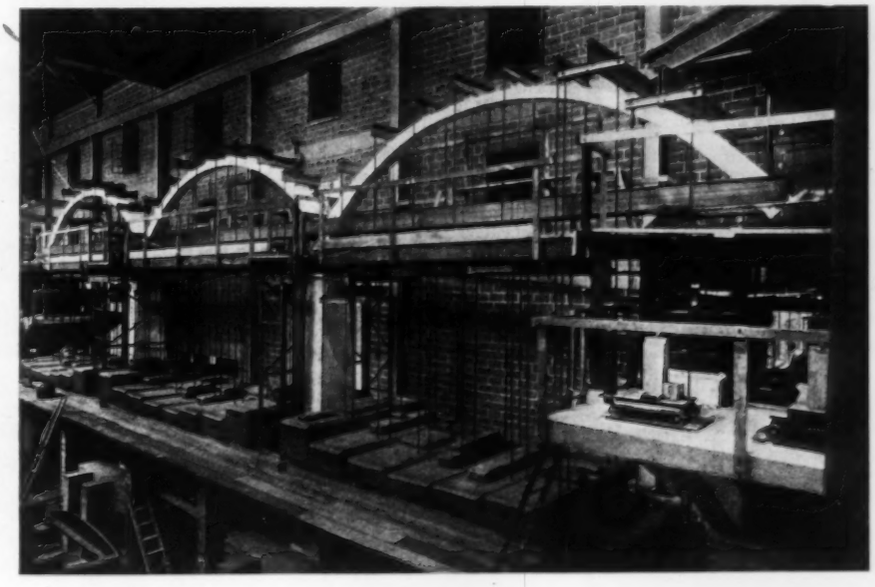
In the past, many engineers have favored the building of gravity dams curved in plan, although various investigations from a purely theoretical point of view seemed to indicate that this type had certain disadvantages. Experience with the Swiss dams would appear to furnish a very strong argument in favor of the curved type wherever the abutments are capable of supporting a reasonable amount of arch thrust.

In this connection the behavior of the Mulholland Dam above Hollywood, Calif., is of interest. This dam is a gravity structure about 200 ft. high, curved on a radius of $R_u = 500$ ft. It was built without vertical contraction joints and, as was to be expected, developed vertical cracks at intervals of between 40 and 80 ft. approximately. I visited the dam on several occasions during construction and later. Shortly after its completion I observed that vertical shrinkage cracks had formed and that there was considerable leakage through several of them. On a visit to the dam two or three years later I was puzzled to see that most of the cracks seemed to have decreased materially in width and that the leakage through them either had stopped entirely or had greatly diminished. Some of the largest cracks had been caulked on the upstream face, thus accounting for the diminished leakage, but others had not been treated at all. In any case, there appeared to be no good reason for the decrease in the width of the cracks, as the reservoir level, and therefore the moisture content of the concrete, had not changed materially during this period. After studying the results of the measurements on the Swiss dams, I suspect that a similar downstream movement of the curved Mulholland Dam in the course of the years may have wedged the structure more firmly between its side abutments, thereby tending to close the cracks and possibly develop a certain amount of arch action, at least in the middle and lower sections.

Similar movement may have occurred in other curved gravity dams in this country, causing contraction joints to close and horizontal arch action to develop contrary to purely theoretical deductions. It would be of great interest to study this problem by means of accurate triangulation measurements similar to those made on the Swiss dams. The pioneer work of H. Zoelly and W. Lang should prove of great value.

THREE-SPAN ARCH RIB ON HIGH ELASTIC PIERS

Reinforced concrete model erected in the Materials Testing Laboratory of the University of Illinois for a cooperative investigation of the load-carrying capacities of the multiple-span structure and to compare the values of reactions and strains measured in the laboratory with corresponding values obtained by the elastic theory. Span of arches 27 ft. 0 in.; pier height 20 ft. 0 in. The investigation now under way is being conducted by W. M. Wilson, M. Am. Soc. C.E., Research Professor of Structural Engineering at the university, representing also the Society's Committee on Concrete and Reinforced Concrete Arches. The research work of this committee is being financed by the Society, the Engineering Foundation, the University of Illinois, and the U.S. Bureau of Public Roads.



Professional Ethics for the Salaried Engineer

Have Young Graduates a Responsibility in Developing the "Souls" of Corporations?

By Arthur E. Morgan

Member American Society of Civil Engineers

President, Antioch College, Yellow Springs, Ohio

FORMULATION of ethical codes for the guidance of the profession is most helpful. But, Dr. Morgan points out, these are prepared almost exclusively for the consulting engineer, to the neglect of that much more numerous class, salaried men largely employed by corporations. Often this group is not supposed to adhere to professional precepts of its own, but merely to accept the standards adopted by employers. In this article Dr. Morgan maintains that it is both the responsibility and the opportunity of the young man to raise the standard of practice—to give the corporation a "soul." This paper is adapted from his commencement address at the Case School of Applied Science last June. His words have special import at this time when so many young graduates are standing on the threshold of professional practice, ready to make their influence felt in the engineering world.

ONE of the marked changes now taking place in American life is the progressive disappearance of the individual entrepreneur. Discounting the present depression, when so many people who lose their positions go into business for themselves, the number of Americans who thus work constantly decreases through the years, as compared with the number who serve under orders in large corporate organizations.

Such study as I have made of the drift of engineering work does not indicate any great change during the past twenty years in the proportion of engineers who work for themselves as compared with those in the employ of large organizations. Of the engineers who have progressed far enough to be members of the national engineering societies, probably between 5 and 10 per cent are administrators or entrepreneurs, and all the rest are working under orders. In some circles the fact that the way for the entrepreneur is not so wide open as it used to be seems not yet to have been discovered.

INDIVIDUALISM VERSUS COLLECTIVISM

The political doctrine of "rugged individualism" still rules in high places. Secretary of War Hurley, in a recent talk before the American Newspaper Publishers Association, said, "Basically, the question before the American people today is individualism against some form of collectivism." "Every man of you here," he added, "is a living proof of the American doctrine of individualism."

Yet every observing person must realize that "some form of collectivism" is an outstanding development of present-day America. In some cases that collective action takes the form of a purely communistic institution like the American public school system, or the fire departments of our cities, by which the community collectively provides service to the individual according to his need, without charging him directly for that service. In other cases, collective action takes the form of a socialist institution like the U.S. Post Office, by which the Government furnishes service to its citizens.

Sometimes communistic and socialistic methods are combined, as in the construction and maintenance of our highway systems, in which the work is largely done by the Government, and is paid for partly from general funds and partly by direct charges in the form of gasoline taxes and motor licenses. Again, collective action may take the form of utility institutions which are semi-public and semi-private, like the American Telephone and Telegraph Company. Or it may operate through private organizations, such as the General Electric Company.

Under these various types of administration, "some form of collectivism" is becoming a dominant characteristic of American industry. I wish to discuss the effect of this condition on the status of engineering ethics.

American engineers have generally been known for their straightforwardness with clients and employers. With few exceptions, they do not bribe, or steal, or loaf on the job. This tradition is so general that it scarcely needs an ethical code to keep it alive. Beyond such standards of decency toward one's employer, what has the salaried engineer to do with professional ethics? Are not policies determined by the employer? What chance is there for a young engineer on a salary to have anything to say about the ethical standards of the company for which he works?

Yet, in the background of every great economic enterprise are the motives of men, which largely determine whether that enterprise will be a social asset or a liability. At every step in the execution of such an undertaking arise questions that have an ethical import. Somewhere, policies must be determined to meet those issues. What part should the salaried engineer have in determining such policies?

To a certain proportion of the young men about to enter the profession this has been a live issue. Some of them have developed their own distinctive ethical standards, which are among their most precious possessions. What chance has the young salaried engineer of maintaining those standards on his job? Must he, on beginning work, surrender any distinctive standards of his own, and simply reflect those of the management?

A PROFESSIONAL CODE FOR THE SALARIED MAN

During the past thirty years most of our great engineering societies have developed fairly well defined ethical codes and, as a result, the level of the engineering profession has been substantially raised. Yet, in general, these codes are formulated on the assumption that ethical problems arise only for those engineers who are in private practice. The idea that ethical judgment should ever be demanded of men working on a salary for great collective organizations seems seldom to have occurred to those who direct the destiny of our principal engineering societies.

Recently two engineering students at Antioch College, William Bruckman and Frederick Herbert, in a study of engineering ethics, emphasized this fact that while most engineers are working on salary for corporations, the ethical codes of engineers are concerned chiefly with the activities of men in private practice. With 90 or 95 per cent of the engineers of the country working on salary, taking orders from public or corporation officials,

most engineers' ethical codes deal with the problems of the remaining 5 or 10 per cent, as though the great mass had no problems of professional ethics beyond those of proper relations with their employers.

To illustrate a point I want to make, let me take an analogy from philosophy. According to the Greek view of life, largely adopted by Christianity, the soul and body are separate entities and can exist independently of each other. The ancient Hebrew belief was very different. The Hebrew did not see soul and body as separate, but spoke of personality, meaning the whole man as an indivisible unit. I am inclined to favor the Hebrew view.

Large corporations are so new on the American scene that we have not yet fully decided where the corporate "soul" is located. A man who for many years was a director of one of the largest and best known industrial corporations in the country recently told me of a remark made by its founder and president about twenty-five years ago. In giving reasons to his directors for certain ruthless action, this president said that a corporation has no soul, that it must always be moved by purely selfish economic motives.

That day is past. Practically every large corporation now claims that it has a soul, and that its motives are not wholly selfish or mercenary. Great improvements in corporate ethics in general justify this claim. However, we are not certain in all cases who in a corporation has the right and duty to exercise ethical judgment on the relations of the corporation to the public it serves.

When a young engineer gets his first job and goes to work for a large corporation, he commonly expects to receive orders, to be informed of policies, and to do as he is told. Policy-making is for the "higher-ups." If questions arise which involve ethical standards and ethical judgment, he may expect the ethical standards of the corporation to be his guide. So far as he is concerned, the soul of the corporation is in its head. The young engineer comes and goes where he is sent and does what he is told. Often he finds those corporate standards higher than his own, and then his work is genuine ethical education. If he does not like the ethical standards of his employer, he may leave his job, but as a rule he can do little to modify them.

ETHICAL STANDARDS IMPROVE

Is this the only possible status of the salaried engineer? I believe not. A story may illustrate my point. It was told to me by Edwin F. Gay, former dean of the Harvard Business School. He related that many years ago as a young man he had a business conference with another young man who was a railroad accountant. This accountant said that in times past the lot of the railroad auditor was not a happy one. The president of the railroad might at any time call in his chief accountant and say that, inasmuch as the road needed to make a better showing, the accountant must falsify his books so that they would show the financial condition which the president desired to present to the public.

Under such conditions the soul of the corporation was in its head. But the young accountant went on to say that a change had occurred. An Association of Railroad Accountants had been formed, and these men, acting "in some form of collectivism," had developed their own professional standards for keeping accounts. Within a short time the prestige of this collective standard became so great that no railroad president would dare to ask his chief accountant to break that code and falsify his accounts. The soul of the corporation was no longer wholly in its head, but the railway organization was approaching the old Hebrew concept of a single unified personality. The young railroad employee who told this experience was Daniel Willard, so favorably known in recent years as president of the Baltimore and Ohio Railroad.

A corporation is not at its best when all its "soul" is in its head. It is in better condition when that "soul" is disseminated throughout its entire organism. Ethical judgment should not rest only in the executive body. Every class of men who serve a corporation in a professional capacity should, by united professional action, formulate and support its own ethical principles.

INFLUENCE OF THE INDIVIDUAL

The individual accountant, engineer, or attorney employed on a salary by a great corporation is largely helpless by himself to sustain ethical standards that are not supported by the management of the corporation. But if his profession as a whole will outline its standards and help its members to sustain them, the collective action will be far more effective.

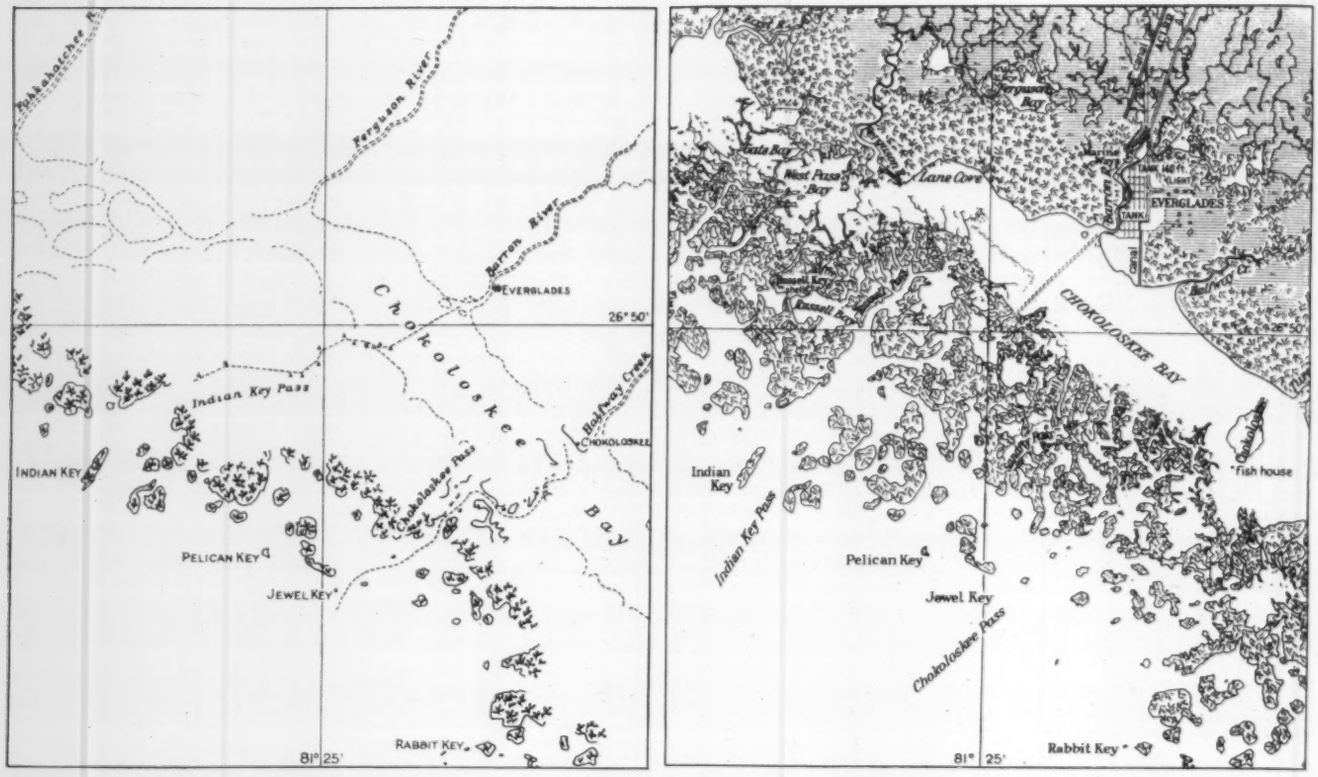
In the ethical codes of the engineering profession the fault is not a positive one, but rather one of inadequate emphasis. Much that is in these codes is applicable to all engineers, whether they are on a salary or working as entrepreneurs. Yet such codes very inadequately reflect the fact that today most engineers are salaried employees. I hope that in years to come the young engineer who takes his first salaried job with a large corporation will find that the ethical principles of salaried employment are well worked out and effectively supported. I hope that he will not find himself a hopelessly insignificant person lost in a great machine, but that he will be expected to exercise ethical judgments in his own field, that he will be equipped to do so, and that when his judgment conforms to the deliberate judgment of his profession, he will find effective support in the engineering profession.

I mention this subject to young men about to enter the engineering profession because the years slip by rapidly, and before long they will be the men who are determining the policies of their profession. It is they who will realize the need for such a development.

One other phase of the maintenance of ethical standards by salaried engineers should be emphasized. If circumstances always suited our plans, there would be no need for character. Character is necessary to go against the current, to do the right thing when it is very inconvenient. Now one of the surest evidences of character is forehandedness.

The engineer who is working on salary may be employed by a corporation having such high standards that he does well to meet them. On the other hand, he may at any time find himself in a situation where he cannot do what is asked of him without compromising himself. Fortunate then is the man who has so handled his affairs that he can be reasonably independent. If he has no financial reserves or other resources, if he is spending beyond his means, he may feel himself helpless in such a crisis and may say to himself that it is useless to go against the prevailing economic system.

For any young man who has ethical aspirations and self-respect, it is very important that he should live well within his means, that he should not try to "keep up with the Joneses," and that by deliberately simple living and self-restraint he make himself to a considerable degree the master of his own destiny. For a man so prepared, the maintenance of sound and discriminating professional standards is not impossible or impracticable.



Plane-Table Map of 1888 — Map Made from Multi-Lens Aerial Photographs

FIG. 1. TWO SURVEYS OF THE SAME SECTION OF COAST MADE AT ABOUT THE SAME COST

Multi-Lens Aerial Photographic Surveys

Florida's Intricate Coast Line Remapped at Low Cost

By O. S. READING

HYDROGRAPHIC AND GEODETIC ENGINEER, U.S. COAST AND GEODETIC SURVEY
WASHINGTON, D.C.

NOWHERE has the usefulness of aerial photography for mapping complex topography and inaccessible country been more strikingly evident than in the Ten Thousand Islands on the west coast of Florida. This region consists of a labyrinth of channels between islands so numerous that at first sight one agrees with an old settler who said, "Call them 'The Ten Thousand Islands'? You mean 'The Nine Million Islands'!"

The intricacies of these channels make a paradise for the yachtsman with a bent for exploration and fishing, but until the advent of the multi-lens aerial camera they presented an unsolvable problem to the surveyor, for it was impossible to map them for any sum not out of all proportion to their value. The plane-table survey of this coast made in 1888 was limited to the outer edges of the islands on this account.

With the development and increasing use of the region during recent years, a new survey was required, and fortunately the Army Air Corps had developed the multi-lens camera. The advantage of the photographic survey methods used may be appreciated from Fig. 1, which shows the old and the new surveys of the same section of coast, both of which were made for about the same cost.

RECENTLY the navigational charts of Florida, from Ormond to Key Largo on the east coast and from Cape Sable to the Caloosahatchee River on the west coast, have been revised by means of aerial surveys. The photographing was done with a multi-lens camera by the Army Air Corps, at the request of the Coast and Geodetic Survey. As a preliminary step in the revision of the charts, line maps of some 2,500 square miles were compiled without contours on a scale of 1:20,000 from the photographs by the Coast and Geodetic Survey. Prints of these line maps proved sufficiently accurate to meet the high requirements of chart surveys and have already found wide use among engineers for various projects where preliminary surveys would otherwise have been necessary. The work has emphasized the advantages of aerial photography not only for the revision of charts but also for the development of engineering projects.

Rapid development of the east coast of Florida during the past decade as well as natural changes due to erosion and accretion along the sandy beaches and inlets, had rendered the old surveys obsolete, so that a complete new topographic survey of this coast was also required.

At the request of the Coast and Geodetic Survey, the U.S. Army Air Corps photographed some 2,500 square miles along both coasts with multi-lens cameras and furnished transformed prints from which line maps to a scale of 1:20,000 were compiled by the Coast and Geodetic Survey. The area photographed and a diagram of the line maps are shown in Fig. 2. The line maps not only have supplied the information needed for the revision of the navigation charts, but also have proved so useful for many other purposes that the re-

sults of the work are believed to be of interest to engineers generally.

AERIAL CAMERAS WITH THREE OR FOUR LENSES

Multi-lens cameras were selected for the work because they effectively photograph a strip nearly four times as wide as that covered by a single-lens camera. From an altitude of 10,000 ft. the multi-lens cameras used photographed a field nearly six miles wide on a scale of about 1:19,000. The width of the field not only reduced the cost of flying to about one-fourth that of single-lens work but also made possible the spanning of many bays, lagoons, and wide rivers, thus greatly reducing the amount of ground control required.

Two photographic expeditions of about six weeks each were made by the Army Air Corps, each expedition consisting of a single amphibian plane with inverted Liberty motor, manned by a pilot, a photographer, and a mechanic. The first expedition set out from Langley Field near Norfolk, with a Bagley tri-lens camera. The photographs obtained, delineated the complicated waterways of the Florida Coast so clearly and showed so much information of value for charting that an extension of the work was requested. A four-lens camera had become available for use on the second expedition, which started from Bolling Field near Washington. The equipment of this expedition is illustrated.

PHOTOGRAPHS BY ARMY AIR CORPS

Credit is due the personnel of the Army Air Corps for the marked efficiency with which both expeditions were conducted. Not a single forced landing occurred although the motors were far from being of latest design, and each plane proceeded some 800 miles from its base to operate for six weeks from indifferent landing fields, without any protection in the way of hangars. On the first expedition a cracked cylinder was discovered and replaced in the field before it had caused trouble.

A temporary ramp was constructed of 2 by 6-in. planking on one of the beaches and used by the amphibian plane for work in the vicinity, as the hull would have absorbed a considerable weight of water if it had not been hauled out frequently. A severe storm, for which it was necessary to triple the lines holding the plane, was weathered without damage on this ramp. The planes were ready at all times and took full advantage of all perfectly clear weather, but photographs were taken only on ten days of the time spent in Florida because of the prevalence of scattered cumulus clouds. All the photographs were remarkably sharp and clear as to detail and were seldom appreciably tilted.

NEW GROUND CONTROL SURVEYS REQUIRED

The only available ground surveys of the requisite accuracy showed little more than the shore line. As this had changed in many places and most of the control monuments had been lost, the photographs could not be plotted by means of the previously surveyed detail. The revision was thus for all practical purposes a complete new survey.

On the west coast of Florida all except two of the station monuments of the original triangulation had been washed away or dug up by treasure hunters. Most of the area was covered by a mangrove swamp containing many trees a hundred feet high. A traverse of a county line, on which the best available axemen worked in relays, had progressed at the rate of only seven miles a month through an accessible part of the area. The original coast triangulation had been done from signals in the water on the west side of the scheme, a procedure that would help little in the control of the photographs. But by the use of Bilby portable steel towers, one of which is illustrated, it was found practicable to extend an arc of triangulation through the swamp at moderate cost, placing the stations from three to ten miles apart.

This work furnished an interesting sidelight on the value of triangulation for reestablishing lost survey

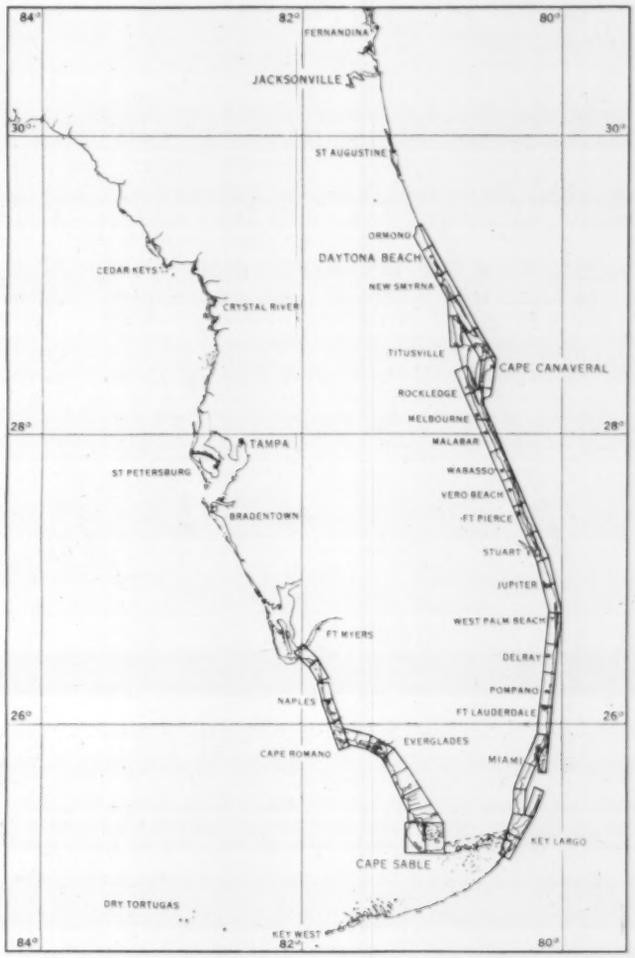


FIG. 2. FLORIDA'S COAST LINE PHOTOGRAPHED AND MAPPED BY THE PHOTOGRAPHIC METHOD

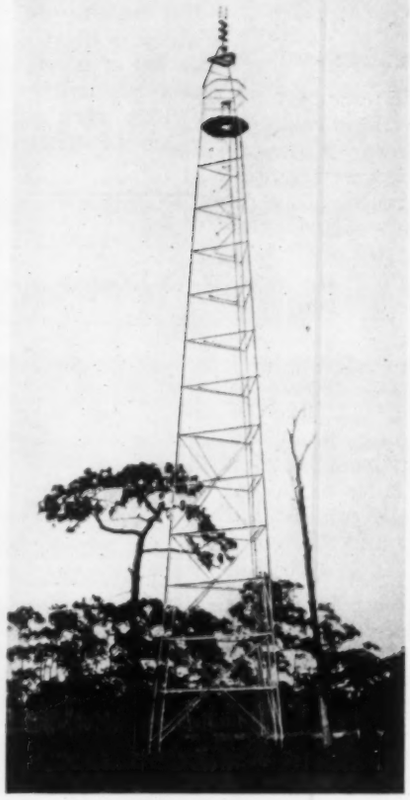
monuments or land boundaries. In the northern part of the section, where it was desirable to start, only one of the original triangulation stations of 1887 was recoverable. An azimuth by Polaris and a base along a railroad were measured. With these data, positions were computed through 11 quadrilaterals of the third-order triangulation—the triangles closing with an error of from 3 to 5 sec.—to a junction with the recovered stations at the south end of the work. The discrepancy between the position carried up through the original triangulation and back through the new, some 120 miles, was less than 6 ft.

Control of the photographs along the east coast consisted principally of third-order triangulation and traverse executed primarily for the control of a hydrographic resurvey. Where this was confined to a beach traverse alone, it was supplemented by spur traverses along roads leading back from the shore at intervals of from five to seven miles. In these the distances were measured with 300-ft. steel tapes and the azimuths determined by solar observations. All the control sur-

veys were executed after the photographs had been taken. The party making these surveys took prints of the photographs into the field and on them spotted the control stations. They also furnished copious notes for the interpretation of the photographs where the character of the vegetation and other details were not clearly distinguishable.

PLOTTED BY RADIAL-LINE METHOD

The compilation of the photographs was done by the radial line method, which has been completely described by Capt. M. Hotine, R.E., in his *Simple Methods of Surveying from Air Photographs*, in *Training Regulations No. 190-27* of the U.S. Army Air Corps, and in the *Topographic Instructions Bulletin 788* of the U.S. Geological Survey. An idea of the method and the modifications used in this work may be obtained from the diagrams shown in Fig. 3. Given good flying technic and terrain of low relief, as in Florida, the angles between the lines radiating from the center (principal point) of the photograph to other points in the photograph are sufficiently accurate for graphic purposes. The photographs thus may be marked with lines radiating from the principal point through objects which it is desired to locate. These lines will correspond to the "cuts" drawn with the alidade from a plane-table station. The photographs thus marked become multiple-arm protractors and whenever three or more suitable ground-control points appear on them, they may be plotted by the usual tracing-cloth method of solving the three point problem.



BILBY PORTABLE KNOCK-DOWN TOWER
105 FT. HIGH
Used for Control Triangulation in the Florida Coastal Survey

As the photographs have an overlap of 60 per cent, every object appears on three adjacent photographs. If the photographs are correctly oriented in turn under the tracing on which the ground control has been plotted, by means of their radials through the control stations, the intersection of the radial lines through each object will give its correct position on the map. Where ground control is not spaced closely enough for orienting each photograph, the intersections along the strip from two photographs which have been plotted by means of ground control may be used to plot the third photograph, as indicated in Fig. 3. Additional intersections farther along on the strip will thus be obtained, from which the fourth photograph may be plotted, and the process continued until more ground control stations are reached.

If the radial lines do not pass through this ground control, the mounting of the composite photographs, the identification of common points on adjacent photographs, and the drawing of the radial lines through them are examined and corrected as necessary. If discrepancies still remain, the strip is re-plotted, and most of the error is thrown into the photographs that show marked evidence of tilt (scale too long in one direction and too short in the other). Usually it will be found that the principal points of such photographs are displaced toward the short-scale side from the regular line of flight, or the exposure interval is shortened on one side and lengthened on the other. A tentative adjustment is made by using a substitute origin for the radial lines that will give more regularity to the line of flight and to the exposure interval as shown by the unadjusted radial line plot of the map.

In the Florida work, care was taken to locate by the intersection method all prominent objects, road junctions, and controlling points at changes in the slope of the ground. Minor detail was adjusted between these points and then traced from the photographs. The tracings were made on the average scale of the photographs so that the adjustment of minor detail between the points located by intersection would be slight. As the photographs were taken from altitudes of about 10,000 ft., with lenses having a focal length of $6\frac{1}{2}$ in., the scale of the tracings was usually about 1:19,000. After the detail of the map had been traced and conventional topographic symbols and names obtained during the field inspection had been added, the tracings were reduced to a standard scale of 1:20,000 and printed by the usual photo-lithographic method employed in reproducing charts.

When the map is printed to standard scale, as many copies can be run off as desired at little more than the cost of the extra paper, usually for about one-fourth the cost of a separate photographic reproduction later. A number of engineers have purchased prints of the photographic compilations, which are on a scale of 1:20,000, in preference to the charts, on a scale of 1:80,000, and have reported substantial savings on preliminary surveys through their use, particularly in the location of waterways and highways.

As the extra copies of the maps are printed on heavy chart paper and numerous precautions are taken to eliminate the distortions so often found in ordinary

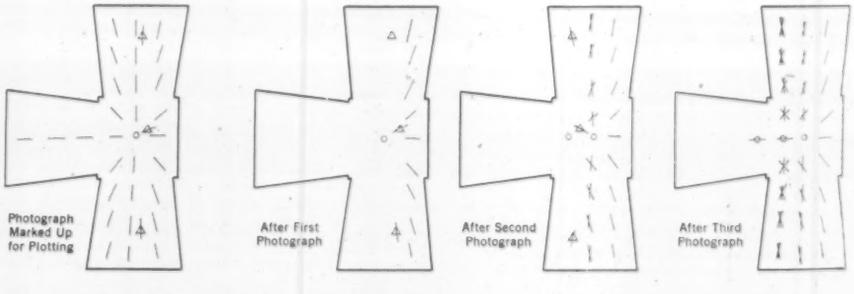


FIG. 3. STEPS IN RADIAL PLOTTING
(1) Photograph Marked with Radials (2) First and Second Photographs Plotted by Radials Through the Control Points; (3) Third and Succeeding Photographs Plotted by Radials Through Points of Intersection on a Line with the Preceding Centers

printed maps, these charts may be scaled with unusual accuracy both for azimuths and distances.

It has been customary in making ground surveys for the revision of charts to include only information of direct interest to the navigator because the cost of such surveys increases in direct proportion to the amount of additional information obtained. In plotting the Florida photographs it was immediately apparent that the only expense of including practically all the detailed information that could be shown on the 1:20,000 scale maps, with the exception of buildings in cities, would be the small cost of tracing it from the photographs. As much of this detail would be of value for other purposes than charting, and as it might also assist in plotting future revisions, about all of it that could be interpreted by conventional topographic symbols was shown on the map compiled from the photographs.

Since the detail was traced from the photographs, instead of being sketched between rod readings from a limited side view by the plane-table method, the maps made from the photographs show each unique feature much more exactly and characteristically than ground surveys. This photographic detail is particularly useful for charting irregular shore lines, complicated inside waterways, and the waterfront of harbors. It enables the navigator quickly to identify his position. In such close quarters any uncertainty due to sketched, generalized, or obsolete topography would probably cause an accident to his vessel. This precision of detail is also of great assistance in orienting oneself on any map and in positively identifying objects used as control for future revisions.

A comparison of the photographic surveys with previous plane-table work and with surveys by other organizations, strikingly emphasized the uniform accuracy of detail obtained in the former. The sketching between rod readings and instrument set-ups could be identified and one could instantly recognize the place where the rodman stopped and pure sketching began at the head of some minor creek or slough. Similarly, the errors in traverses were apparent as well as the gradual adjustments by which they were made to close.

It is of interest to note that the photographs gave definite evidence of the southward movement of Cape Canaveral (Fig. 4). Along this part of the east coast of Florida the successive cycles of beach accretion have thrown up low sand ridges and formed sloughs parallel to the coast, but immediately north of Cape Canaveral, these sloughs and ridges are almost at right angles to the present shore line. South of it the successive accretions show a gradual curving caused by the southward movement of the cape. This evidence is confirmed by the southward movement of part of the carefully located high-water line, amounting to 650 ft. since the plane-table survey of 1877. The topographers of that survey, with their limited view of the ground, completely missed the significant trend of the ridges and sloughs. By means of the photographic compilations (Fig. 4) the successive positions of the cape in its journey southward can be clearly traced.

Many handicaps to accurate plotting were evident in the Florida surveys. The failure of the detail to match along the junction of the separate prints of the composite photographs indicated an uncompensated shrinkage of film and paper, differences in focal length and distortion of the several camera lenses, and a general maladjustment of the camera. The four-lens camera had been rushed to the work without the usual calibration tests. This difficulty was corrected to some extent by photographing a tall building with this camera from across a 120-ft. street and using the lines of windows to determine a new set of relations between the composite prints. When the fourth chamber was so adjusted, the discrepancies in preliminary plots were reduced to less than half those obtained with the three-lens camera.

The four-lens camera was also of great value in stepping the plot across broad rivers and bays where the principal points of one or more photographs fell in the water and could not be identified in adjacent photographs. Discrepancies of as much as 50 m. on the 1:20,000 scale ($2\frac{1}{2}$ mm. on the map) were not uncommon in the first plot of a 5-mile strip between control stations. Considering this and other errors in the photographs, the sheets as finally adjusted and compiled have been found by a recent test to be surprisingly accurate.

A number of airway beacon lights were located by independent triangulation or traverse. The maximum discrepancy found between them and adjacent map detail was $\frac{1}{2}$ mm. on the map, or 10 m. on the 1:20,000 scale. It is probable that greater errors exist on the sheets along the edge farthest from the coast. In order to show as much information as possible from the available photographs, detail was traced all the way out to the edges of the wing prints, where the intersections of the radials which locate the detail are very acute and therefore weak in a direction normal to the line of flight. Had high accuracy for such information been considered essential to the project, a second strip should have been flown inshore and the photographs twisted 30 deg. from the line of the first set and overlapped as far as the center prints.

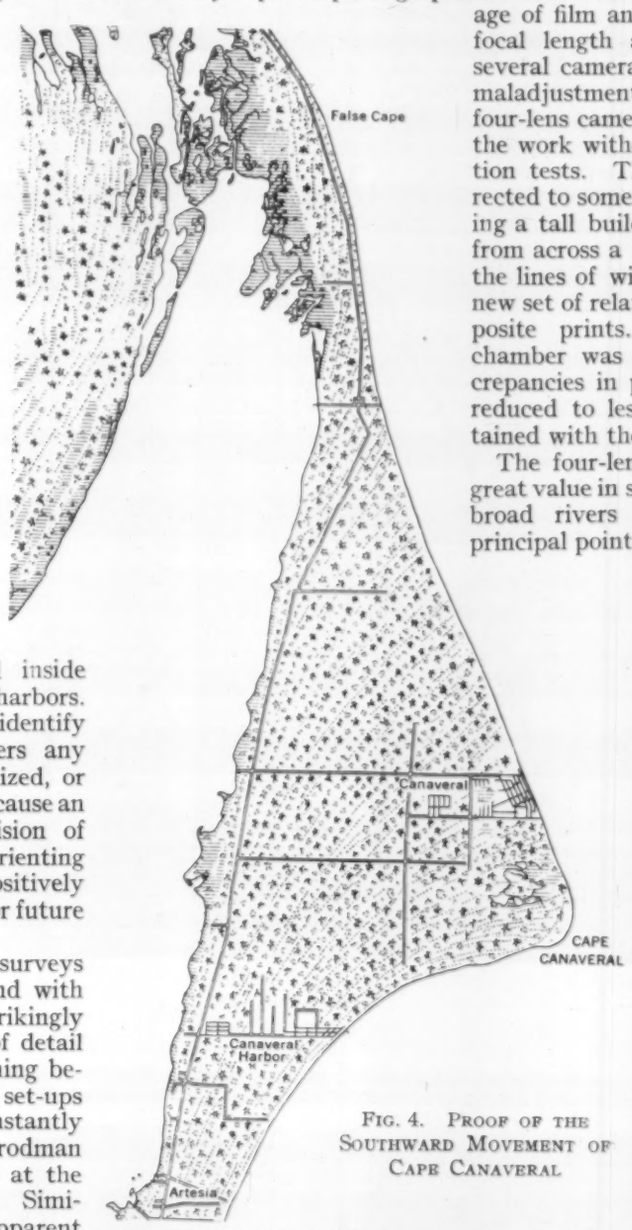


FIG. 4. PROOF OF THE SOUTHWARD MOVEMENT OF CAPE CANAVERAL

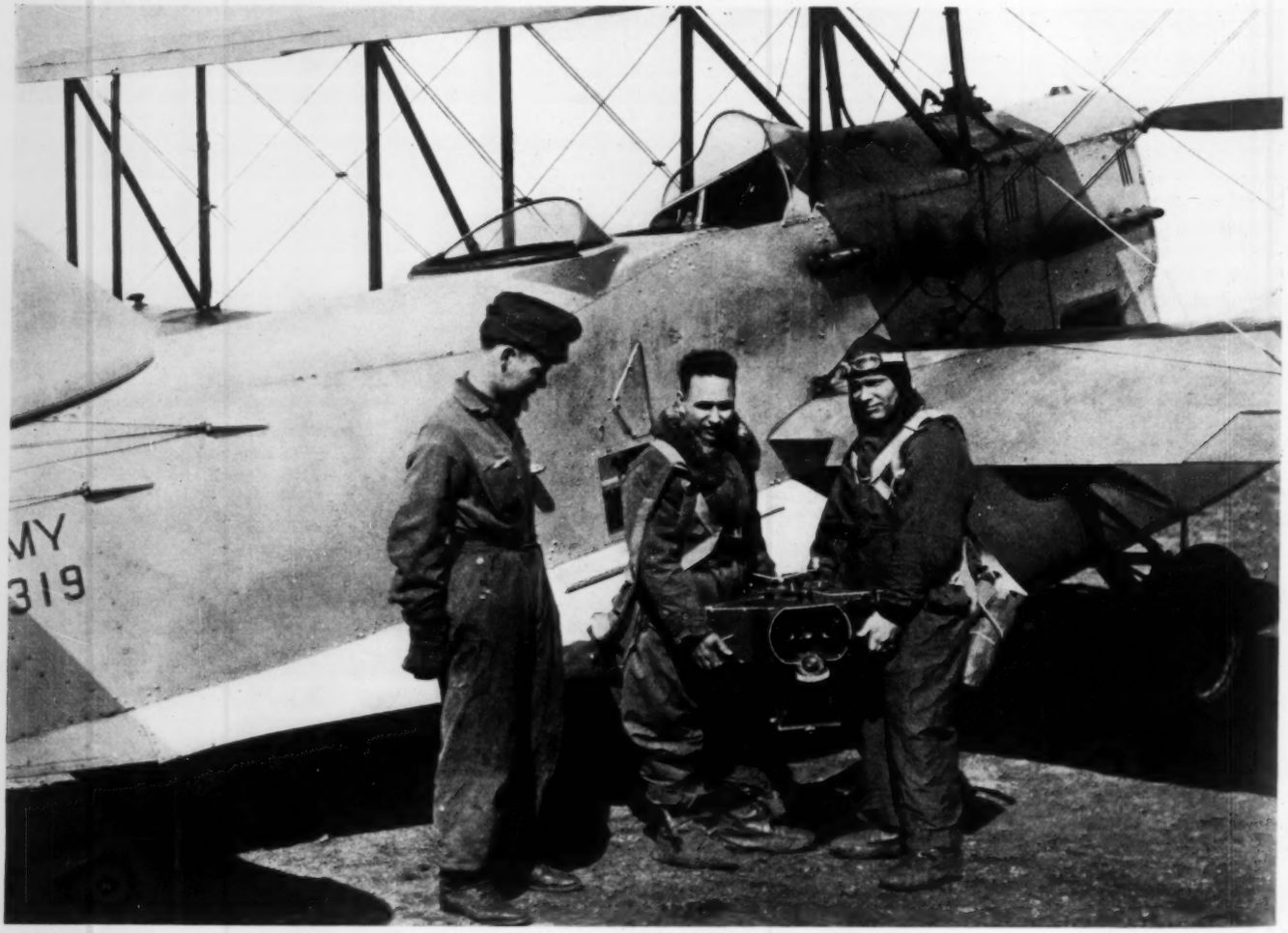
A Study of the Aerial Photographs Shows Ridges Formed by Wave Action Which Indicate Accretion or a Static Condition When Parallel to the Shore, and Erosion When Intersecting It

On the Florida sheets the maximum errors occurred where it was necessary to use several consecutive photographs whose centers fell in the water and therefore could not be identified on adjacent photographs. It is absolutely essential for accurate plotting that as few as possible of the principal points (centers) of the photographs fall in the water. This fact cannot be too strongly emphasized. It should be carefully noted by all concerned with photographic surveys adjacent to any considerable body of water.

FUTURE PROGRESS IN MAPPING

Since the Florida photographs were taken, a five-lens camera which photographs a field ten miles across, on a scale of 1:20,000 from an altitude of 10,000 ft., has been developed by the Army Air Corps. With a 60 per cent overlap, each photograph spans the principal points of five photographs ahead and five behind along the flight strip instead of one ahead and four behind, as with the four-lens camera. Both the experience in Florida with the four-lens camera and advance information from an experimental survey with the five-lens instrument indicate that the highest graphic accuracy may be obtained in plotting the photographs from this camera with less than half the ground control usually required by the plane-table method. Furthermore, it makes no difference whether these control stations are screened from each other by trees or intervening hills, a serious handicap in the plane-table method. If suitable precautions are taken in flying and photographing with such multi-lens cameras, it will be practicable, for terrain having differences in elevation of less than 20 per cent of the flying altitude, to compile maps in which every outstanding object is shown with the same accuracy with which the control stations are plotted. Every permanent distinctive object on such maps thus becomes in effect a monumented control station for compiling future revision photographs or for compiling and adjusting all other surveys in the area on the same or smaller scales.

Such maps will furnish enough distinctive objects, such as street intersections, grade crossings, and building foundations, to make possible the accurate plotting of aerial photographic revisions without further ground control until the growth of the country requires maps on still larger scales. This is demonstrated by the use of aerial photographs in archeological explorations. By means of such photographs it has been possible to trace many of the ancient Roman road systems in Great Britain by differences in the appearance of the vegetation, which were apparent in the photographs but not on the ground. Similarly, the sites of ancient cities and villages have been discovered by aerial photographs when the uncoordinated and limited views available from the ground were insufficient for the purpose. It is evident that, once an aerial survey based on geodetic control has been plotted with the highest graphic accuracy, it will supply ample detail for accurate revisions by means of aerial photographs for an indefinite period of years.



PERSONNEL, PLANE, AND FOUR-LENS CAMERA OF THE SECOND PHOTOGRAPHIC EXPEDITION

Radley Bridge Supported on Pre-Cast Piles

Structure at Christchurch, New Zealand, Built by City Engineer's Department

By W. G. Morrison

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ON THE other side of the globe, the City of Christchurch, New Zealand, completed in 1930 a reinforced concrete highway bridge across the Heathcote River, an estuary. To provide maximum clearance at flood stage, the 74-ft. continuous spans are rigidly attached to the two intermediate piers. The ends of the floor beams at the abutments are supported on rockers set in bitumen. In some respects the structure is similar to the Garden Street Bridge recently completed at New Braunfels, Tex., described by J. W. Beretta, Jun. Am. Soc. C.E., in the May issue. The Radley Bridge, however, is supported on pre-cast concrete piles driven with a drop hammer into a soft blue sand and clay. Carefully kept records of the pile driving and descriptions of several ingenious construction methods used on the work add to the interest of the article.

AS PART of a four-year road construction and paving program totaling over a million dollars, the city of Christchurch, New Zealand, built a three-span continuous-beam concrete structure over the Heathcote River between May and December 1930. The bridge was constructed by the City Engineer's Department on an estimate basis, in competition with private contractors.

The site was previously occupied by an old swing bridge which had not been opened for 30 years. At the bridge site the river has a tidal range of 5 ft. at spring tides. Ferry Road, an important traffic artery which runs along the river 50 ft. from the end of the bridge, is only 5 ft. above high spring tide and $2\frac{1}{2}$ ft. above flood level. The bridge had therefore to be of the type requiring least depth, and since reinforced concrete construction had been definitely adopted for all city bridges constructed under the current program, the choice lay between a through type and a multiple-span deck type. The decision was in favor of a three-span deck bridge with a camber of 1 ft. to give the required headroom. This is rather more than is demanded by architectural considerations. The beams were spaced 4 ft. apart from center to center so as to occupy less depth, but this spacing probably did not make for economical design. Traffic considerations led to the adoption of a 10-deg. skew in alignment.

The bridge is 28 ft. wide between curbs, 42 ft. wide overall, and has side spans of 23 ft. and a central span of 28 ft. The deck slab, which is 6 in. thick, is covered with a 2-in. bituminous wearing surface.

For a three-span bridge, particularly where appearance requires a small depth at the center of the beam and a greater depth over the piers, the continuous-beam type offers many advantages in economy of material. This type, however, is subject to undesirable stresses induced by the settlement of the supports. In the case of the Radley Bridge, settlement was provided for by several means: (1) by using an ample margin of safety in pier and abutment design; (2) by leaving a gap at the center of the bridge to be poured after the settlement due to dead load had taken place; (3) by allowing in the calculations for a differential settlement of $\frac{1}{4}$ in. either in the piers or the abutments; and (4) by placing permanent bench marks on the bridge so that settlement might be closely watched and any necessary measures taken during construction. Although calculations showed that the center moment in the 28-ft. span would be reduced 20 per cent by the second means listed, during construction it was found possible to open the bridge one month earlier by ignoring this provision.

A surface examination showed the site to be covered with about 3 ft. of soft mud on which it was impossible for a man to stand. A test boring on each bank revealed that the underlying strata were as shown in Fig. 1. Pile foundations were decided upon, but for the sake of appearance and to prevent the collection of weeds and driftwood, piers with cutwaters were built on top of the piles. Before the bids were invited a timber test pile was driven near each bank. These test piles made it apparent that no highly resistant stratum would be reached at a reasonable depth, and that the piles would be dependent entirely on friction for support. For this reason the piles were tapered to transfer the load more certainly to the strata through which they passed and were made square in section to give increased surface area. The amount of taper was decided upon arbitrarily; the 16-ft. abutment piles tapered from a cross-section 12 in. square to one 8 in. square; and the 30-ft. river piles, from one 16 in. square to one 12 in. square.

In actual practice the square tapered pile is somewhat easier to cast and seems less likely to be deflected from the vertical

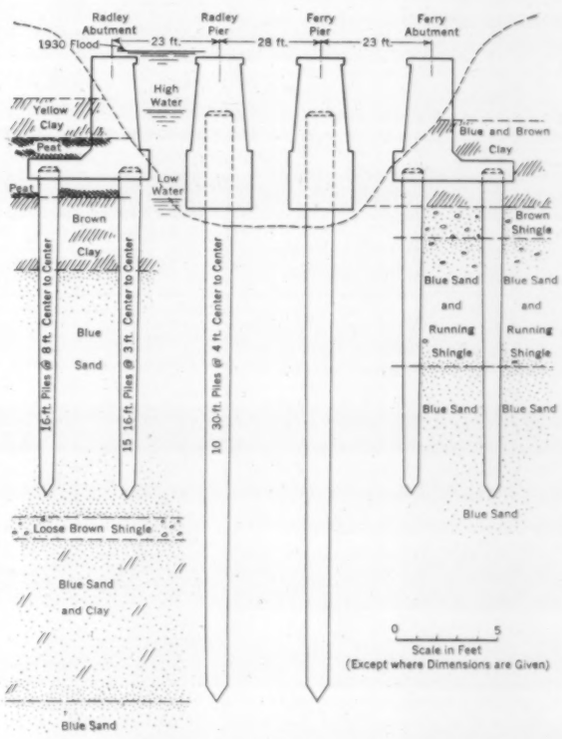


FIG. 1. RADLEY BRIDGE, ABUTMENTS AND PIERS
Showing Nature of Foundation Materials

in driving, but it cannot be reinforced as easily or effectively as, for example, an octagonal pile of uniform section. Near the heads both diagonal and square stirrups were used with a richer mix of concrete, but it was found very difficult to make every stirrup fit snugly. Close helical binding is probably superior.

The piles were cast on a fixed platform with removable partition boards, and were lifted by a gantry with eyebolts screwed into plates cast into the piles. The eyebolts were greased and re-used. Forged shoes were first employed, but later a simple shoe made of $^1/_4$-in. welded

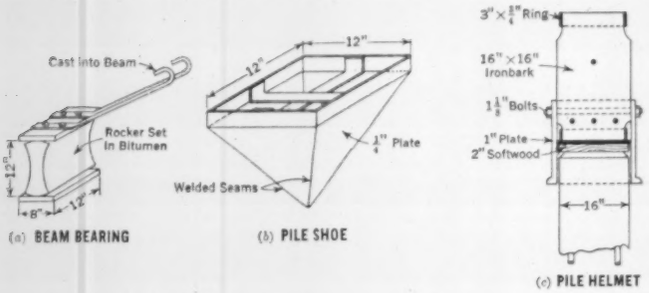


FIG. 2. CONSTRUCTION DETAILS OF ROCKER BEARING
Pile Shoe, Pile Helmet, and Follower

steel, costing less than half the forged shoes, was tried, and since large boulders were not encountered, proved perfectly satisfactory. Details of the shoe used are given in Fig. 2*b*.

Central pipes for water jets were cast in the first piles but were of little use. A 1-in. pipe alongside the pile using the town water pressure of 100 lb. per sq. in. was preferable. Even with this poor water supply, the jet was very useful in sinking the piles past obstacles and in pulling into line any piles that ran out of position.

At each end of the bridge the abutment and the two wing walls were designed as a unit, forming a rigid U-shaped box, supported on piles along the front and sides and filled with earth. Only the vertical reaction of the bridge superstructure is transmitted to the abutments, the end of each beam being supported on a rocker set in bitumen (Fig. 2*a*). The abutments therefore are largely relieved of settlement, temperature, and shrinkage stresses. The load on the abutment foundation is 0.7 ton per square foot on the footing, or 12 tons per pile. Since the abutment showed a settlement of not more than $^1/_{16}$ in. and the footing is on rather soft clay, it may be assumed that the piles are taking most of the load.

The pier load is carried entirely by the piles, which take 26 tons each. The pier itself has sufficient rigidity as a beam to distribute the load evenly over the piles. The superstructure is fastened rigidly to the two piers, the assumption being that temperature or shrinkage movement will deflect the piers laterally without inducing stresses of any magnitude.

CONSTRUCTION FEATURES

The abutments were enclosed in 2 by 6-in. tongue-and-groove red pine sheet piling 10 ft. long, thoroughly strutted and braced. The 16-ft. abutment piles were driven with a skid driver rig supported on the sheeting, so as to keep it clear of high water. Power was supplied by a friction winch mounted on, and driven by, an old motor truck. The 3,360-lb. drop hammer used, was tripped by hand. As the truck had ample speed but a poor starting pull, the hammer rope was taken through triple block leads on the face of the derrick. Although this method appeared tedious because of the low horizontal pull, no derrick guys and but little bracing of the staging were required. This rig maintained a speed of 10 blows per minute. An ironbark follower 12 ft. long, of 12 by 12-in. timber, with a steel plate helmet, was used to drive the piles below the base of the hammer leads. No cushioning except a folded cement bag was required.

The concrete in the old abutments was shattered with gelignite and hoisted onto the stagings by a gantry. As the abutment footings were above low water, valves consisting of 1-ft. lengths of 3-in. pipe, flanged and capped, were set in the sheeting near low-tide level. At low water the caps were unscrewed, allowing the abutments to drain, and before the tide rose again the caps were replaced. This device, shown in Fig. 5, proved a simple yet very effective method of dewatering the forms, and it greatly reduced the pumping required. The abutment forms were hung and braced from the staging until high-water level was reached. The staging was then dismantled.

As illustrated, the piles of the river piers were driven from the old swing bridge, which was found to revolve quite freely after its long disuse. The outer end was carried on a 4 by 12-in. timber set on clusters of 2 by 6-in. sheeting driven into the river bed. The driver was moved longitudinally and the bridge revolved to spot any particular pile. The bridge and driver were then chained down and the pile, weighing $2^3/_4$ long tons, was hoisted over the water by means of the hammer rope and two hand winches. The drop hammer used on the 30-ft. piles weighed 7,600 lb. and was hoisted by a steam roller on the river bank. The tendency of the bridge to revolve as driving progressed was reduced by running the driving rope around a heavy snatch block mounted at the center of the turntable. The hammer was run back to the turntable on a length of railway track each time the bridge was revolved. A steel helmet and an ironbark dolly with 2 in. of soft wood packing, as shown in Fig. 2*c*, were used to preserve the pile heads.

FORMS SUPPORTED OVERHEAD

Pier forms were made up on the bank and hung from the pile heads, as shown in Fig. 5. The floor was cut and fitted around the piles at extreme low tide, the work then being only 6 in. below water. Strips of felt were cleated against the piles to make a tight joint. Before pouring the bottom pier section, the piles were thoroughly roughened and bound loosely with No. 3 gage wire. The pile tops were removed after the bottom section had hardened and the top section was then poured over the pile stumps. The bottom section is thus supported by

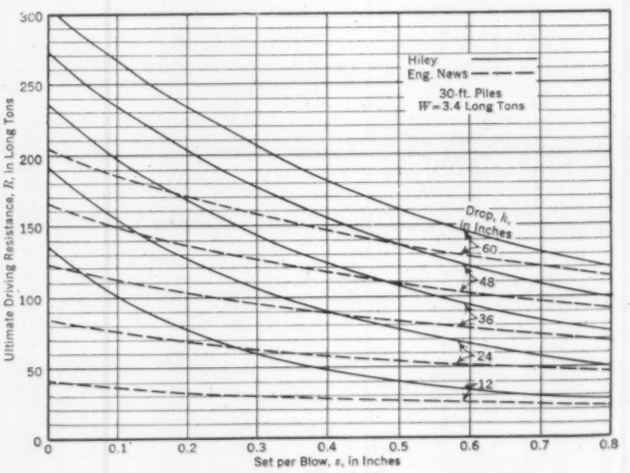


FIG. 3. PILE DRIVING FORMULAS COMPARED
Heavy Drop Hammer on Long Piles

its grip on the piles and also by steel hangers from the top section. The worst flood in forty years occurred at this stage of the work, but owing to the program of working from overhead without obstructions in the river, the damage was negligible.

As shown in a photograph, a ledge having a minimum width of 3 in. was formed in the concrete of the abutments and piers, partly for architectural effect, and partly for constructional reasons. From this ledge the main beam and slab forms were braced, none of the centering being supported on the soft bottom of the river. A settlement of only $^3/_{16}$ in. occurred in the center of each span when the beams and slabs were poured.

The curb forms and handrails were set to the true camber independently of the beams. The balusters of the handrail were pre-cast in special forms, faced with galvanized iron.

WORKABLE CONCRETE MIX USED

A $^1/_4$-yd. mixer of tilting drum type was used for the concrete. Washed sand and screened graywacke pebbles were used. Mechanical analyses were made but the determining factor in the mix was its "workability" with a view to securing a good face. With this object in view, an excess of sand was used. In consideration of such factors as variation in aggregate, variation in initial water content of the sand, the personal element of the operator, segregation of the mix in transport and ramming, together with the difficulty of making laborers understand that every corner without exception must be thoroughly spaded, it seems a mistake to pay too much attention to theoretical considerations, and then neglect rigorous supervision. A 2,000-lb. concrete, homogeneous throughout the structure, is far better than a 4,000-lb. concrete which has been too stiff to be properly worked in close around reinforcing and which contains occasional patches of "honeycombing." Every effort was made to secure thorough ramming, and the uniform appearance of the stripped concrete justified the care taken.

SURFACE FINISHED BY RUBBING

Contrary to the usual practice in Christchurch, the specifications provided that the concrete be finished by rubbing down with carborundum stone after the forms were removed. This method was specified to save the cost of plastering, and because plastering often covers a multitude of sins in the concrete itself. If the plaster is omitted, the concrete must be rammed and worked to a smooth surface and is much more likely to be sound throughout.

Actually, it was found that the saving was not large, owing to the greatly increased labor in finishing the forms, particularly for work with many curves, batters, and angles. The rubbing was done by hand, the best results being obtained by stripping the forms on the fourth day and rubbing the concrete surface with a wet stone. By this means the material ground off was worked into a paste which filled all pinholes in the surface and gave a rough textured finish very like that of plaster.

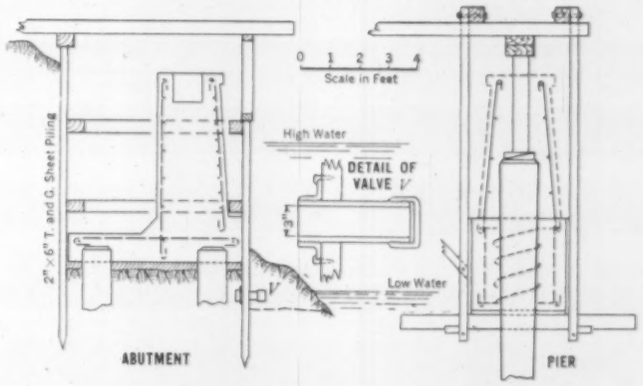


FIG. 5. DETAILS OF ABUTMENT AND PIER FORMS

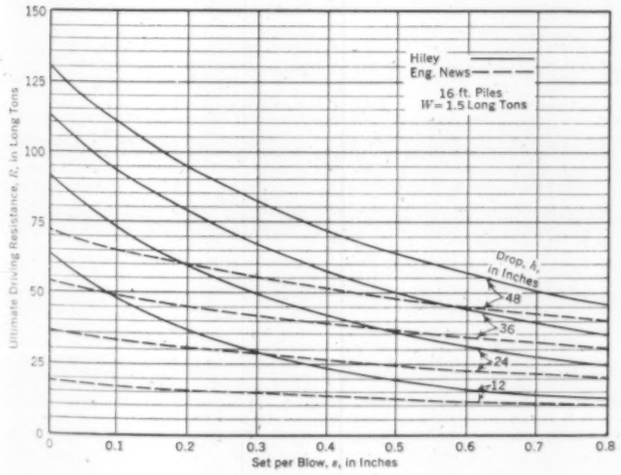


FIG. 4. COMPARISON OF PILE FORMULAS
For Light Drop Hammer on Short Piles

PILE DRIVING FORMULAS COMPARED

There are in Christchurch more than twenty bridges on pile foundations, yet when the present building program was commenced, no information whatever was available as to the depth, driving resistance, or settlement of a single pile. The paper by Charles Terzaghi, M. Am. Soc. C.E., "The Science of Foundations," in PROCEEDINGS, Vol. 93 (1929), and the subsequent discussion form a good background against which to examine any data on pile driving. Although a static loading test is of greater value than a pile driving formula, yet in many cases such a test is not made, and in its absence the use of the formulas will no doubt be continued. Of the many formulas in use, engineers in practice find that the majority lead to most inconsistent results if the various factors entering into the calculations are varied.

The ideal formula should give the same ultimate resistance to driving for a pile no matter what the weight of the hammer, the height of fall, or the type of helmet used. Unfortunately, so many considerations are involved and a proper calculation of their exact effect is so complex that the "ideal" formula is abandoned in search of the "practical." The much maligned *Engineering News* formula is at least simple and almost invariably conservative. Attention should be drawn, however, to the formula presented recently in *The Structural Engineer* (London) for July 1930, by A. Hiley. This formula has a theoretical basis, is not too complicated, and, as the following examples indicate, it gives reasonably consistent results.

USE OF THE HILEY FORMULA ILLUSTRATED

The Hiley formula,

$$R = \frac{\eta^{Wh}}{s + \frac{c}{2}} \quad \ldots\ldots\ldots\ldots [1]$$

was applied to the 30-ft. river pier piles, which were reinforced with four $1^1/_8$-in. longitudinal rods. In the formula:

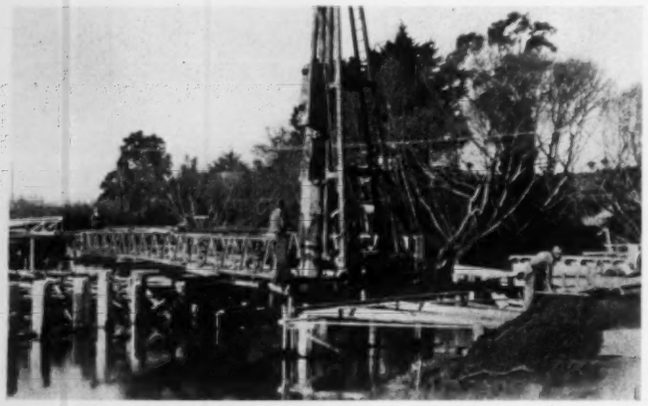
W = weight of hammer, 3.4 long tons
P = 2.75 long tons (weight of pile) + 0.22 long ton (weight of dolly)
= 2.97 long tons
e = coefficient of restitution, taken as 0.2 for a drop hammer acting on a wooden-capped concrete pile.

Then, according to Mr. Hiley, the efficiency of the blow (η) is found as follows:

$$\eta = \frac{W + Pe^2}{W + P}$$

$$= \frac{3.4 + 2.97 \times 0.04}{6.37} = 55 \text{ per cent} \quad \ldots\ldots\ldots\ldots [2]$$

If h is taken as the height of the free fall of the hammer in inches, then the energy available for driving the pile



OLD SWING BRIDGE SUPPORTING PILE DRIVER
Used for Driving Pier Piles

equals $\eta Wh = 0.55\ Wh$ inch-ton. This energy is expended in driving the pile through a distance of s inches, under a temporary compression of helmet c_c; of pile, c_p; and of ground, c_q.

Substituting in Equation 1, in which R equals the ultimate driving resistance of the pile in tons,

$$R = \frac{0.55Wh}{s + \frac{c_c + c_p + c_q}{2}} \quad \ldots\ldots\ldots [3]$$

When R equals 200 tons, c_c was assumed as 0.20 in.; c_p was calculated as 0.22 in.; and c_q was assumed as 0.08 in. Or, $c = c_c + c_p + c_q = 0.50$ in.

Assuming that c varies as R, then $c = 0.0025\ R$ and $\frac{c}{2} = 0.0012R$.

Formula 3 now becomes:

$$R = \frac{0.55\ Wh}{s + 0.0012\ R} = \frac{1.87\ h}{s + 0.0012\ R}, \quad \text{or}$$

$$s = \frac{1.87\ h}{R} - 0.0012\ R \quad \ldots\ldots\ldots [4]$$

A set of curves for different values of h has been plotted in Fig. 3.

For the same conditions, the *Engineering News* formula is $R = \frac{Wh}{s + 1}$, or

$$R = \frac{3.4\ h}{s + 1} \quad \ldots\ldots\ldots\ldots [5]$$

For purposes of comparison this formula is also plotted in Fig. 3. It will be noted that the results given by the two formulas do not differ greatly for penetrations of more than 1 in. per blow.

The Hiley formula was applied as follows to the 16-ft. abutment piles, which were reinforced with four $^7/_8$-in. rods:

In the formula,
W = weight of hammer, 1.50 long tons
P = 0.78 long ton (weight of pile) + 0.40 long tons (weight of ironbark dolly 12 ft. by 12 in. by 12 in.)
= 1.18 long tons
e = 0.2 as before

Substituting as before in Equation 2, the efficiency of the blow (η) is:

$$\eta = \frac{1.5 + 1.18 \times 0.04}{2.68} = 58 \text{ per cent}$$

For R = 100 tons, assume c_c as 0.20 (for cap); calculate c_p as 0.20 (for pile and dolly); and assume c_q as 0.10. Or, $c = 0.50 = 0.005\ R$, and $\frac{c}{2} = 0.0025\ R$.

$$\text{Then } R = \frac{0.58\ Wh}{s + 0.0025\ R} = \frac{0.87\ h}{s + 0.0025\ R}$$

$$s = \frac{0.87\ h}{R} - 0.0025\ R \quad \ldots\ldots\ldots\ldots [6]$$

These values are plotted in Fig. 4. In Fig. 4 are also shown values found by the *Engineering News* formula, in which

$$R = \frac{Wh}{s + 1} = \frac{1.5\ h}{s + 1} \quad \ldots\ldots\ldots [7]$$

These calculations contain uncertain elements, that is, e and c_c. These cannot be determined without much experimental work and do not greatly affect the result. The value of $(c_p + c_q)$ may be found by means of a set gage or by the very simple method of pasting a piece of paper on the pile and, with the hand supported on an independent rail, draw a pencil line as the hammer strikes. The pile will thus make its own record of the amount of temporary compression. Figs. 3 and 4 were drawn before the pile driving commenced, and were referred to throughout the work. The following data indicate the greater consistency of the Hiley formula. Wherever loads are shown in tons the long ton of 2,240 lb. is referred to.

TABLE I. SAFE LOAD IN TONS ON THE NORTH TEST PILE
A 28-ft. Timber Pile Driven with a Hammer Weighing 1,120 lb.

Drop in Inches	Set in Inches	Safe Load in Tons: By Hiley Formula	Safe Load in Tons: By *Engineering News* Formula
144	0.92	33	37
99	0.63	32	30
48	0.28	31	19
99	0.60	33	31
144	0.76	38	41

Values for the Hiley formula range from 31 to 38 tons, and those for the *Engineering News* formula range from 19 to 41 tons.

For a 12-in. drop, the pile head showed a temporary compression of 0.25 in., or $c_p + c_q = 0.25$. The assumption for Table II was 0.30 in. for R = 200. There-

TABLE II. SAFE LOAD IN TONS FOR A 30-FT. CONCRETE PILE
Driven with a 3.4-Ton Hammer

Drop in Inches	Set in Inches	Safe Load in Tons: By Hiley Formula	Safe Load in Tons: By *Engineering News* Formula
48	0.16	214	141
36	0.10	198	113
24	0.03	180	80
12	0.00	138	42
48	0.18	207	139

fore 0.25 in., for $R = 135$, is reasonably correct. For a 60-in. drop, the diagram showed that $c_p + c_q = 0.28$ in. and $s = 0.42$ in.

Certain engineers have at different times advocated reducing the hammer drop until the permanent set is zero and basing resistance calculations on the data thus obtained. This procedure has much to commend it. As $c_p + c_q$ can be easily measured for these conditions, and as all the energy of the blow must go into temporary compression, the result should be fairly reliable. Table III indicates that a calculated resistance based on "no set" is conservative for both formulas considered.

TABLE III. SAFE LOAD IN TONS FOR A SECOND 30-FT. CONCRETE PILE
Driven with a 3.4-Ton Hammer

DROP IN INCHES	SET IN INCHES	SAFE LOAD IN TONS: By Hiley Formula	SAFE LOAD IN TONS: By *Engineering News* Formula
48	0.31	174	126
60	0.36	191	150
21	0.08	148	70
16	0.06	135	53
12	0.01	135	42
60	0.42	177	145

SETTLEMENT DURING CONSTRUCTION

Bench marks were established on the pile heads and transferred as the work progressed to permanent brass screws set over the piers and abutments. More than 20 observations were made with a level reading to 0.001 ft. Differences of 0.003 ft. were observed due to errors of observation, but it was satisfactorily established that over a period of six months following the pile driving the settlement was substantially as shown in Table IV.

Piles for the Radley abutment showed a decrease in set after a period of rest. The other piles, being less influenced by the stratum of impervious clay, showed no change. Records of this nature are only too scarce and must prove of great value for future work in the same locality.

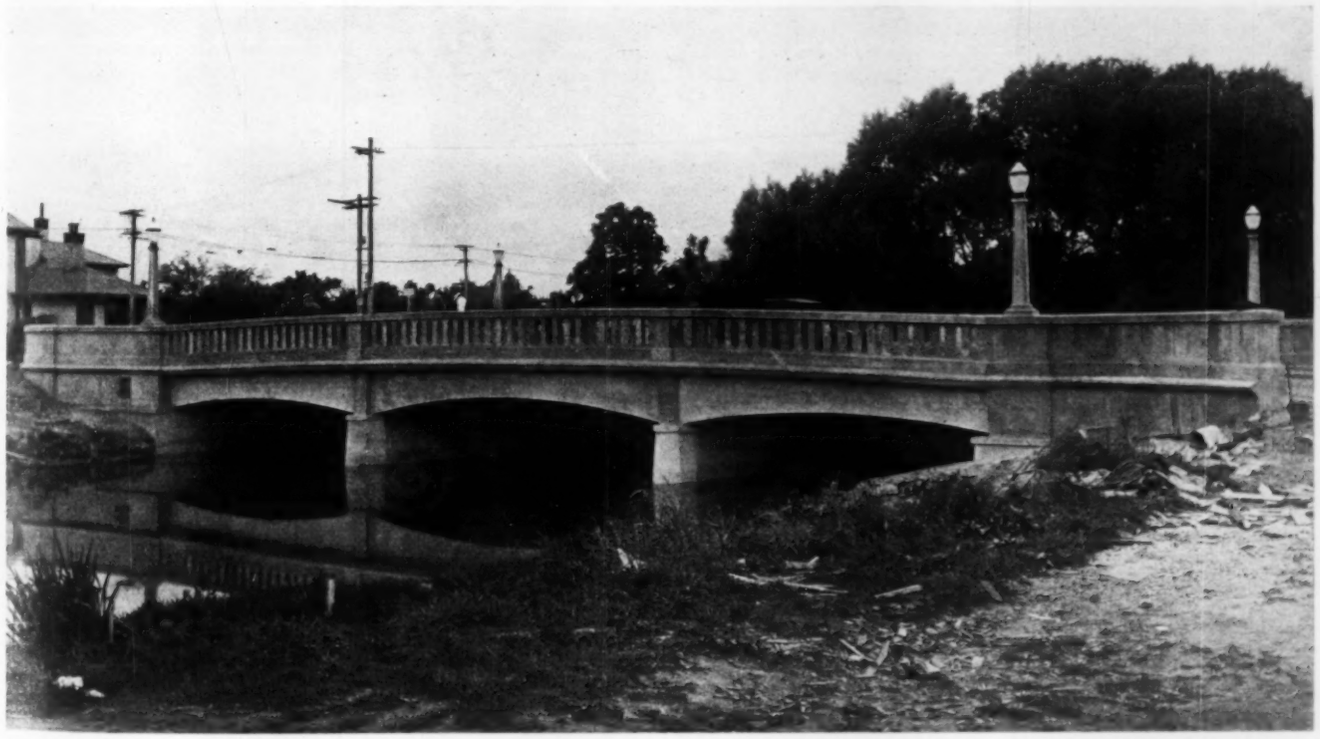
DAY LABOR VERSUS PRIVATE CONTRACT

The work was done by the City Engineer's Department after a rather heated controversy in the City Council on the relative merits of day labor and private contract. The City Engineer's estimate was 3 per cent below the lowest of the seven private bids and 25 per cent below the highest. The department was at a disadvantage in the matter of equipment and also had to build up its whole organization of bridge labor for this one piece of work. Final computations showed that the City Engineer's estimate was overspent by 7 per cent; thus the amount actually spent exceeded the lowest private bid by 4 per cent.

A few data will indicate the extent of the work. In the pre-cast piles, 52 cu. yd. of concrete and 17,700 lb. of steel were used, while the piers and superstructure of the bridge contained 386 cu. yd. of concrete and 43,200 lb. of steel. The cost of the structure was almost exactly $20,000. The work was done under the general supervision of A. R. Galbraith, M. Am. Soc. C.E., City Engineer of Christchurch. I was responsible for the design and was resident engineer in direct charge of the construction of the bridge.

TABLE IV. SETTLEMENT OF PILES DURING SIX MONTHS FOLLOWING DRIVING

LOCATION	PILE LENGTH IN FT.	PILE WEIGHT IN TONS	HAMMER WEIGHT IN TONS	DROP IN IN.	SET IN IN.	DRIVING RESISTANCE IN TONS: By Hiley Formula	DRIVING RESISTANCE IN TONS: By *Eng. News* Formula	DEAD LOAD IN TONS	SETTLEMENT IN FT.
Radley Abutment	16	0.78	1.5	24	0.6	31	23	10	0.008
Radley Pier	30	2.75	3.4	36	0.33	136	93	18	0.009
				24	0.19	130	70		
Ferry Pier	30	2.75	3.4	36	0.26	150	99	18	0.009
				24	0.13	144	72		
Ferry Abutment	16	0.78	1.5	24	0.12	70	32	10	0.002



RADLEY BRIDGE COMPLETED IN 1930 OVER THE HEATHCOTE RIVER, NEW ZEALAND

OUR READERS SAY—

In Comment on Papers, Society Affairs, and Related Professional Interests

Improving Fire Insurance Risks

TO THE EDITOR: In connection with the plan of water works betterment to relieve unemployment, approved in principle by the Board of Direction and published on page 268 of the April issue of CIVIL ENGINEERING, I should like to make a suggestion. The municipalities in Virginia are divided into four classes by the Fire Insurance Underwriters for rate-making purposes. Other sections have as many as ten classes. Class 1 is the best risk and enjoys the lowest rates. Succeeding classes have successively higher rates.

The principal fire insurance companies prefer better risks with lower rates rather than otherwise. Fire underwriters stand ready to make new inspections and re-rate promptly on completion of rate-changing improvements. They are prepared, also, to issue general specifications for the improvements necessary to secure a specific, better class rating for a municipality and to approve detailed plans and specifications before the improvements are started.

The class into which a municipality falls is determined by the water supply and distribution system and fire-fighting facilities. My plan, therefore, involves selecting municipalities in classes other than the first and improving their water supply and distribution systems and their fire-fighting facilities, thereby gaining for them better classifications (not necessarily the first) and lower rates. I propose that the improvements be financed entirely out of savings in fire insurance premiums thus brought about, without municipal borrowing or bond indebtedness. The plan contemplates using unemployed engineers and local, unemployed labor as far as available.

I contemplate that the funds would be furnished by local banks or syndicates, as needed, to a limit set by a definite estimate on the approved specifications and under a carefully drawn trust indenture. The indenture should provide for depositing all available existing fire insurance policies and their renewals; the more deposited, the quicker the liquidation. It should cover payment of original premium on policy renewals, to the bank by the insured, from the date of the indenture to the liquidation of the loan, interest and cost; payment of return premiums to the bank by the insurance companies; payment by the bank of the full amount it receives, to the insurance agents until the lower rates become effective, and the reduced premium thereafter; utilization of the return premiums and savings as a curtail on the loan; and return of the policies after the liquidation of the loan.

Fire insurance rate-making structures are too extensive to admit of general estimates illustrating group savings or time required for liquidation; however, the individual examples shown in Table I are enlightening.

TABLE I. INSURANCE RATES PER $1,000 RISK

TYPE OF BUILDING	4TH CLASS		3D CLASS		2D CLASS	
	Build'g	Cont's	Build'g	Cont's	Build'g	Cont's
Frame Dwelling	$0.47	$0.47	$0.32	$0.32	$0.24	$0.36
Frame Mercantile Range	$6.56	$6.56	$5.21	$5.21	$5.15	$5.15
Brick Mercantile	$2.20	$2.46	$1.17	$2.02	$0.94	$1.85
Frame Hotel	$3.95	$3.95	$2.76	$2.76	$2.48	$2.48

To execute this plan, leaders will be required to place the matter before local citizens, organizations, municipal officials and bodies, and bank officials. No municipal action would be required except an agreement to take over and operate the improved systems in accordance with the requirements of the insurance underwriters.

The advantages of this plan are as follows: employment for engineers and labor, preferably local; stimulated purchase of materials, affording widespread employment; no delay because of charter bond limits, issuance of bonds or delayed Federal loans; lower fire insurance premiums in the protected area; no cost to citizens, policyholders, or municipalities for the improvements; increased value of the locality for industry and homes; and possibility of greater insurance recovery if change is from fourth to any other class.

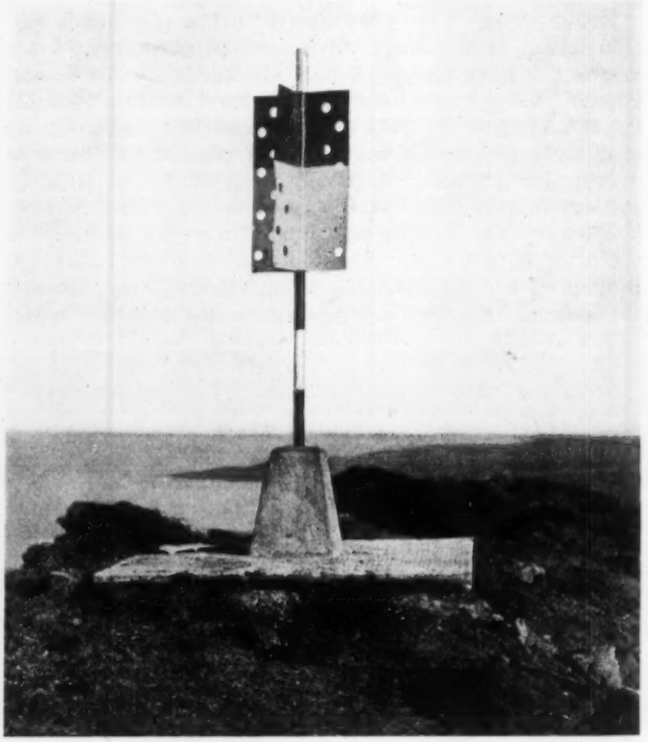
I believe the basic idea of utilizing fire insurance premium savings is sound, as applicable to municipalities and as already generously practiced by industry, and that liberal positive thinking will overcome all seeming difficulties.

CHARLES M. ANDREWS, Assoc. M. Am. Soc. C.E.

Richmond, Va.
June 23, 1932

Advantage of Land Courts

DEAR SIR: The excellent paper by Mr. Syme, in the March number, shows the importance of geodetic methods and surveys in providing basic data for engineering projects generally. This is in line with the fact that good maps are essential to good engineering plans, and that geodetic methods and control are basic to the making of good maps. One of the prime virtues of triangulation—



TRIANGULATION STATION "KILAUEA" ON KAUAI ISLAND, T.H.
Showing Permanent Observing Platform and Demountable Pole and Target Signal

the ability to recover or reestablish its stations—has given it peculiar value in cadastral surveying.

Geodetic control for property surveys is most valuable and most economical when used through the medium of state land courts, such as are now maintained in Massachusetts and in Hawaii. In a paper prepared some years ago by Clarence B. Humphreys, Chief Engineer of the Massachusetts Land Court, the general functions of that court are briefly stated as follows:

"The Massachusetts Land Court was established in 1898, and in addition to establishing the ownership of the land it also determines the boundary lines, which lines remain definite and fixed and are not disturbed by adverse possession within the meaning of the law.

Thus all precautions are taken to secure an accurate survey and plan supplemented by sufficient monuments to enable all lines to be replaced at any time. This plan, called the filed plan, is made by a private engineer under instructions approved by the court and costs are paid by the petitioner in each case."

Examination of the rules laid down by both the Massachusetts and the Hawaii courts shows that, in the final adjudication of a boundary, permanence is given its location by tying it in, wherever practicable, to the geodetic control stations in the vicinity. Hawaii has made this provision generally practicable by the extension of chains of triangulation around the margins, and in the interior, of its islands, where property surveys are particularly difficult because of the large number of small, irregularly-shaped parcels of land involved. Further, Hawaii has made the stations of these control surveys easily accessible to surveyors by erecting over them permanent structures. Each of these structures consists primarily of a concrete observation platform with a metal signal pole, carrying a target, which passes through a hole in the platform and is plumbed directly over the station mark. This pole remains in position at all times except when a station is occupied for observations.

Following the example of Massachusetts and Hawaii, land courts should be organized in other states and territories. To these courts would be brought all disputes and questions involving titles and boundaries of real property; and decisions made by such courts would be as nearly final as such things can be, since they would rest on a foundation of basic indestructible geodetic data.

It can thus be seen that the national triangulation system, supplemented by local horizontal control surveys, has a real value to every owner of land, whether a farm or a city lot. The time when the execution of an arc of triangulation was generally considered to be only the interesting experiment of very impractical men has long since passed. Mr. Syme's paper is the kind that shows how waste can be avoided in carrying on the many activities of our people.

WILLIAM BOWIE, M. Am. Soc. C.E.
Chief, Division of Geodesy
U.S. Coast and Geodetic Survey

Washington, D.C.
June 25, 1932

Misuse of Legal Term

SIR: Professor Kittredge's article in the July issue on "The Future of the Railways" is sound and impressive. There is one point, however, on which I should like to comment. He says, "In prosperous times the railways should be allowed to earn something more than a fair return to tide them over the periods of depression which as yet seem inevitable." The question immediately arises: Can any return be "fair" which is less than the railways "should be allowed" to earn?

Throughout his article Professor Kittredge makes frequent use of the word "fair." This perpetuates what, to my mind, is a very serious error, which had its inception in the famous case of Smyth vs. Ames and has endured to complicate every subsequent consultative, administrative, legislative, and judicial activity connected with rate regulation. By introducing this term of ethics into its opinion instead of using the legal term "reasonable" to express what was undoubtedly meant, the Supreme Court opened the door to interminable argument involving ethical considerations upon which agreement is hardly to be expected.

It is not merely the use of "fair" in the paragraph quoted that accounts for the paradox. It is Professor Kittredge's implied assumption that a rate of "fair" or reasonable return is a fixed quantity, above which a rate should be permitted to go in times of prosperity and below which it may be expected to go in periods of adversity.

Is it not, rather, the fact that a rate of reasonable return in a specific field is one that bears such a relationship to rates in other fields that a reasonable proportion of the total available capital will be induced to enter the specific field? This rate will inevitably fluctuate, as do all rates under the influence of fluctuating demand for and supply of capital.

A rate of reasonable return is high in times of prosperity and low in times of adversity. The failure of the Interstate Commerce Commission to recognize this fact has contributed greatly to the present plight of the railroads, but it is unlikely that an attempt to counteract the effects of that failure by increasing rates, which changed conditions have already made relatively high, will prove successful.

WALTER R. AVERY
Poling and Avery, Engineers

New York, N.Y.
July 5, 1932

Trucks for Feeders

TO THE EDITOR: The article by Professor Kittredge, in the July issue, is very timely. As he has stated, the country certainly cannot get along without the railroads for at least some time to come. Although there is a popular misconception to the effect that highways and airways are about to snatch the last bit of railroad business, it is difficult to imagine large bulk shipments being adequately handled by these newer forms of transportation.

As highway congestion grows, the drivers of pleasure cars more and more loudly protest against the enormous buses and trucks, which obstruct the roads. Since these drivers are voters, their protest may well lead to restrictive legislation and regulation.

In order to prevent overcrowding of highways with long-distance commercial traffic and to use all transportation facilities to the best advantage, it seems that proper coordination of the various facilities is the most reasonable solution. The use of trucks as freight feeders to rail service, as recently instituted on the St. Louis Southwestern Railway Lines is an example of this. Similarly, the New York Ontario and Western Railway has substituted buses for trains to take care of light local passenger traffic. Such limitation of each type of transportation to the field in which it can serve best should be beneficial to carriers and public alike.

PHILIP H. WARD, Jun. Am. Soc. C.E.

Westfield, N.J.
July 7, 1932

Design of Theodolite Axis

DEAR SIR: The article by Mr. Bowie on "The Standard Theodolite of the U.S. Coast and Geodetic Survey," in the June issue, is of interest because it presents a technical problem concerned with the use of precision instruments and lays emphasis on the double cone bearing with coincident apexes, which embodies a fundamental principle. The high precision required for geodetic work, as far as the instrument itself is concerned, is dependent largely on development of the vertical axis, which at times has been called the "soul of the instrument." The precision of the graduations of the instrument plate is fundamentally related to the axis of the dividing engine upon which the graduations have been made.

I encountered the problem of designing and making such an axis in the construction and building of six circular dividing engines, three of which were destroyed by the San Francisco catastrophe of 1906. When it became necessary to build a machine at once, the work was accomplished in a comparatively short period. Difficulty was encountered due to the unavoidable change in temperature from 32 to 70 deg. fahr., because this machine had to be housed in a temporary frame building heated by an ordinary coal stove. When the room was heated in the morning, the expansion of the outer column with the axis bearings took place before the heat could reach the axis and consequently the instrument lost its free motion. This caused considerable delay and slowed up the work. The difficulty was overcome by replacing the upper cone of the axis with a cylinder and an adjustable collar bearing.

I have applied this principle of construction to two other machines subsequently built, which satisfy the most rigid requirements.

ADOLPH LIETZ, SR., Affiliate Am. Soc. C.E.
President and Manager, The A. Lietz Company

San Francisco, Calif.
June 27, 1932

Bi-Party Bonds Are Fair

DEAR SIR: I have read with much interest the letter by H. G. Hunter in your May issue. His point regarding the one-sidedness

of present contractual guarantees is indeed well taken.

Last year it was reported by many members of the Associated General Contractors of America that they had faithfully fulfilled the performance of their construction contracts, but that the owners had failed to make payment therefor. As a result of this condition, the Associated General Contractors of America initiated a movement for "bi-party" bonds. Such a bond would guarantee performance by the contractor and payment by the owner. If the owner could be prevailed upon to place funds in escrow at the time the contract is signed, this would, of course, be the best possible arrangement and would guarantee the availability of funds for periodical payments when due.

For some mysterious reason it is currently presumed that only contractors fail to comply with their contractual requirements. This is not always the case, particularly in times of economic depression. Furthermore, contractors have not been the only ones to suffer in such cases. Being the last to receive their fees, the designers have also suffered in cases of financial default. In view of these facts, it would seem timely for engineers, architects, and contractors to jointly demand "bi-party" bonds of their clients.

If more engineers will frankly face the condition as Mr. Hunter has, "bi-party" bonds can and will be obtained. If the demand is created, surety companies will undoubtedly provide the supply. Such a bond is particularly applicable in the case of land under lease or under contract for sale.

There is seemingly no more reason to doubt the integrity and responsibility of the constructor than of the owner. In any kind of contract it is presumed that both parties are equally and mutually responsible. This idea of "bi-party" bonds is therefore presented in the hope that it will serve in the future as a solution for financial difficulties in which engineers and contractors now find themselves involved through no fault of their own, but as a result of having been too trustful of their clients, who in turn were perhaps themselves too hopeful or optimistic at the time the construction contract was executed.

A. P. GREENSFELDER, M. Am. Soc. C.E.
President, Fruin-Colnon Contracting Company

St. Louis, Mo.
May 31, 1932

Hydraulic Flow Against Gradient

TO THE EDITOR: The interesting article by Mr. Grunsky, in the June issue, recalls the field observations and research on the same problem in which I was engaged at intervals during 1919 and 1920. The resulting report took the form of a paper, "Control of Flood and Tidal Flow in the Sacramento and San Joaquin Rivers, California," published in Vol. 84 (1921) of TRANSACTIONS.

The phenomenon of fresh water overriding the salt water was plainly in evidence during high stages of spring flow at Army Point, Benicia Arsenal, Calif. There, as utilities officer, I directed the pumping of several million gallons of fresh water at favorable phases of the tide, for shop and garden use during an unusually severe drought. The momentum or inertia of the tidal prism caused it to continue flowing inland for some time after the reversal of slope; thus the denser saline volume underran the broad sheet of turbid flood water flowing toward the Golden Gate.

Recent problems and investigations in connection with the Intracoastal Canal system have revealed the importance of inertia and momentum as factors in non-uniform flow. Thus the velocity computed by a hydraulic formula for uniform flow may be radically different from that actually observed; and the disturbing factor is evidently inertia.

The following quotation from the paper on "The Cape Cod Canal" by the late William Barclay Parsons, Hon. M. Am. Soc. C.E., published in Vol. 82 (1918) of TRANSACTIONS, clearly describes the phenomenon of continued flow after reversal of the gradient.

> A singular outcome of this phenomenon is that, with equal end elevations following Buzzards Bay falling tide, there is a current with an average mean velocity of more than 1 knot per hour, although at that instant there is no head to produce it. When the current velocity is zero (or slack water), there is a difference in head in Cape Cod Bay over Buzzards Bay of 1.5 ft. Between those limits of time (30 min.) the water in the canal is actually running up hill, from a maximum current of 1.1 knots when the slope is level to a current of zero velocity when the adverse head is 1.5 ft. On the other tide, when the end elevations are equal, the mean current velocity is 0.74 knot, and when the velocity is zero the adverse head, opposite to what has been producing flow immediately previous, is 1.0 ft.
>
> The explanation of these phenomena of lag lies in the dynamic properties of moving liquids. A time interval is required to develop full momentum imparted by an extraneous force, in this case the full momentum not being reached until after its creating force has passed the apex of its energy. In like manner, momentum when once set up continues unaided until absorbed by friction or checked by a new and opposing force. . . . .

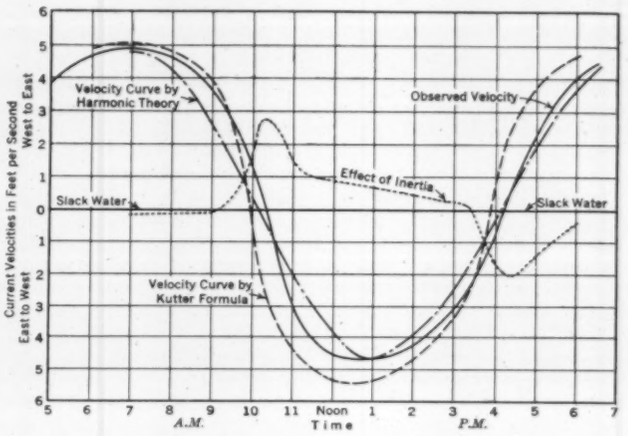


FIG. 1. VELOCITIES COMPUTED BY DIFFERENT FORMULAS COMPARED WITH OBSERVED VELOCITIES

On the accompanying diagram (Fig. 1) adapted from Mr. Parsons' paper, I have ventured to make graphic representation of inertia by means of the added curve, shown by a dotted line. Its ordinates are the difference between the observed velocity and the velocity computed by a uniform flow formula. Here then is a case of water running up hill.

C. S. JARVIS, M. Am. Soc. C.E.

New York, N.Y.
June 17, 1932

Automatic Control at Traffic Circles

DEAR SIR: The interesting article by Mr. Swan on "Traffic Circles and Rotary Traffic," in the July issue, should do much to convince skeptics that the engineering aspects of traffic cannot be ignored if safety and efficiency are to be obtained from the street system. The general recommendation that street cars conform to the rotary principle is, however, open to debate. In several instances, it has been found preferable to operate street cars straight through the circle, protecting the movement with stop-and-go traffic signals. Instead of using the ordinary fixed-time signal, a mechanism actuated by the passing car throws the signal against motor traffic only when the street car is about to use the intersection and only for as long as is necessary. Changes of this sort have recently been considered in Washington where the street cars now operate in the same manner as other traffic. In a circle as large as the Place de L'Etoile, a photograph of which is shown on page 428 of Mr. Swan's article, the movement of street cars in the regular flow of traffic would undoubtedly be preferable to a direct crossing, even though traffic signals were used.

Although Mr. Swan reiterates the statement that the fixed path of the street car makes it a "distinct liability" to all traffic, he also recommends designing the entrances to traffic circles in such a way that vehicular traffic is confined to definite paths, thus enabling every operator to know in advance the direction of all other vehicles. Why fixity of direction should be an advantage to motor traffic but a detriment to rail traffic is something for which I have never been able to find an explanation.

In explaining how vehicles, in passing through traffic circles, are enabled to weave without difficulty and unnecessary hazard, Mr. Swan computes the spacing of vehicles passing through a circle, assuming a speed of 20 m.p.h. and a volume of 900 vehicles per lane per hour, at approximately 230 ft. It is quite true that the spacing of vehicles approaching the circle at 40 m.p.h. will be 230 ft. when each lane carries 900 cars per hour, but if the speed is reduced one half, with no change in traffic volume, the spacing must similarly be reduced exactly one half. Thus the difference between the actual spacing and the minimum safe spacing while passing around a circle, under the assumed conditions, will be about 46 ft. instead of 161 ft.

HAWLEY S. SIMPSON, Assoc. M. Am. Soc. C.E.
Research Engineer, American Electric Railway Association

New York, N.Y.
July 8, 1932

Another Tape Diagram

DEAR SIR: I read C. D. Shepard's article, "Nomographic Chart for Steel Tapes," in the July issue with a great deal of interest, since I had occasion to consider the same problem about a year ago. The method developed is very simple and readily applied in the field. The charts may be cut out and pasted in a notebook for permanent reference and use.

Some tapemen do not like to use the nomograph in the field. Also, the use of this chart becomes rather complicated when a large number of measurements must be made under varying conditions so I believe that curves for each tape, as shown in Fig. 2 of Mr. Shepard's article, are more useful.

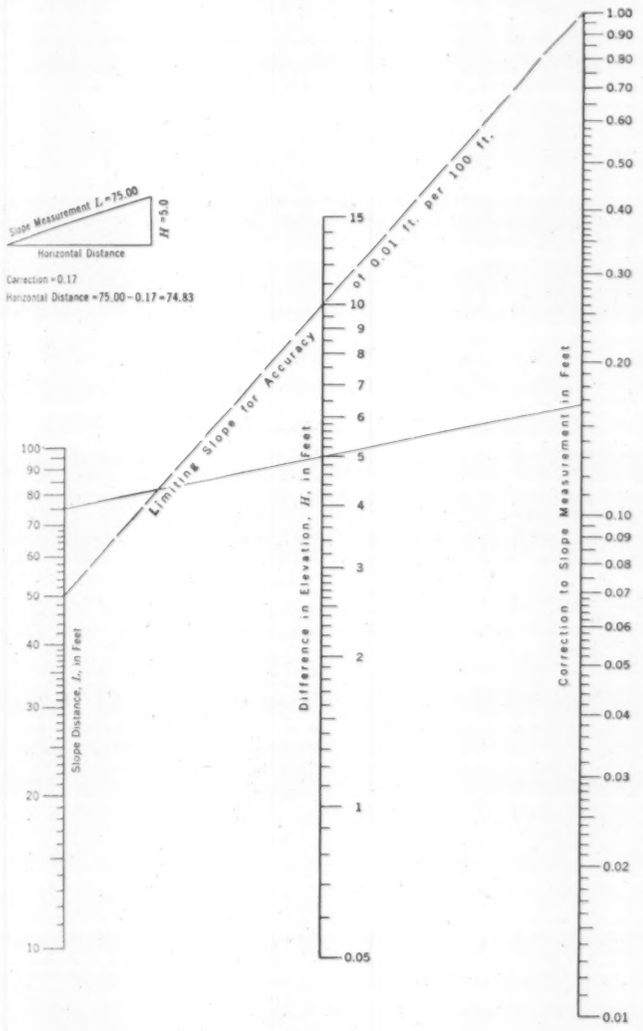


FIG. 1. SLOPE CORRECTION DIAGRAM FOR STEEL TAPES
For a Difference in Elevation of More Than 20 Per Cent of the Slope Distance Use Precise Calculation

In using tapes wound on a reel, I have found that the ribbon will not lie perfectly flat and straight unless some initial tension is applied. This may require a pull of as much as 6 or 7 lb., which may be greater than the calculated tension of accuracy. For this reason I have been accustomed to determine the tension of accuracy, which most authors call "normal tension," for the standard temperature and to make a separate temperature correction. This is probably the common practice.

A temperature correction chart may be plotted very easily to simplify the field calculation. The normal tension may be determined from the lower three lines of Mr. Shepard's nomograph, using the values of P_0 on the P_x scale. If the chart is to be used with a single tape, it would be better to re-label the lower scale to give values of d, the unsupported span, instead of $\frac{A\,E\,w^2\,d^2}{24}$.

Another tape correction which must frequently be made in the field is the slope correction. The accompanying nomograph (Fig. 1) gives these corrections for the usual range of values as plotted from the customary but approximate formula: Slope correction $= \frac{h^2}{2L}$, where h is the difference in elevation and L is the slope measurement. When the difference in elevation is more than 20 per cent of the distance measured the results become too much in error and a precise determination should be made.

JOEL M. JACOBSON, Jun. Am. Soc. C.E.
Assistant Professor of Civil Engineering
Armour Institute of Technology

Chicago, Ill.
July 5, 1932

Progress in Street Naming

TO THE EDITOR: The article by Mr. Schwada on "Street Names and House Numbers," in the March issue, is an able contribution to the subject. Of particular interest is the proposed use of names, rather than letters or numbers, for the east and west streets, and the arrangement of these in alphabetical order from the axis outward. In some cases, an extension of this idea may be worth considering. For example, the east and west streets north of the axis might be given botanical names, in alphabetical order, such as Alder, Beech, Cedar, and Cherry, while those to the south could be given personal or place names. Streets east of the meridian might be numbered and those to the west designated by letter.

Such a system would accomplish the desirable end advocated by Mr. Schwada—namely, elimination of the use of suffixes to designate the proper quadrant. Of course, where possible, the naming and numbering system should be extended in one direction from some natural barrier, such as a bay or lake, along the city boundary.

Attention should be called to the fact that, in cities of rough topography, the rectangular street pattern may be the exception rather than the rule; and in new developments there is generally a well defined trend away from the rectangular system, and this is likely to continue. A modern conception of the city includes conveniently located centers for residence and recreation, for business and for industry, suitably connected by radial and circumferential thoroughfares, but with minor streets designed primarily for access rather than for the movement of through traffic. In order to function successfully in such a plan, a street system may depart far from the rectangular pattern; and it seems doubtful if any naming and numbering system, based on the principle of coordinates, could readily be applied to it.

Perhaps neighborhood names will again come into general use, as they have in some cities today, and will be considered a necessary part of the official address. Houses, of course, will continue to be numbered and there will be the same need which now exists of avoiding duplication in street naming. Perhaps, however, the neighborhood name will furnish more accurate and more readily understood information than could be hoped for in even the most carefully devised system.

WILFRED JUPENLAZ, Assoc. M. Am. Soc. C.E.
Assistant Engineer, Morris Knowles, Inc.

Pittsburgh, Pa.
June 24, 1932

SOCIETY AFFAIRS

Official and Semi-Official

Emergency Relief and Construction Act of 1932

In Relation to "A Normal Program of Public Works Construction to Stimulate Trade Recovery and Revive Employment"

ANALYSIS BY JOHN P. HOGAN, M. AM. SOC. C.E.
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IN accordance with the resolution adopted by the Executive Committee of the Society on May 9 last, a Committee on Public Works was appointed and instructed to use its best efforts to make the principles enunciated in the resolution operative in fact. A record of the procedure appeared in the June issue of CIVIL ENGINEERING.

This committee has labored assiduously and with a most gratifying success. The Emergency Relief and Construction Act of 1932, which passed both Houses of Congress on July 16, and received the signature of the President of the United States on July 21, embodies with a very marked degree of parallelism the principles expressed in the Society's resolution.

The act is here analyzed by Chairman J. P. Hogan, M. Am. Soc. C.E., whose personal aid during many weeks of this development was constantly at the disposal of the Administration and of Congress. Acknowledgment for similar personal aid should be given to Malcolm Pirnie, M. Am. Soc. C.E., and for support and guidance to Messrs. Harrison P. Eddy, Alonzo J. Hammond, and Joseph Jacobs, Members Am. Soc. C.E. These five comprised the Committee on Public Works.

THE Emergency Relief and Construction Act of 1932 was signed by the President of the United States on July 21. The act is divided into three sections designated "Titles."

Title I provides for loans of $300,000,000 through the Reconstruction Finance Corporation to states and municipalities for direct relief. The act requires that interest be paid on such loans at the rate of 3 per cent and that the money be paid back by the state or municipality. If not paid back by states, the money is to be deducted from the Federal Aid Road Appropriation over a period of five years, beginning in 1935. Not more than $45,000,000 may be loaned to any one state, and loans made to either states or municipalities require a certification from the governor of the state in regard to the necessity for such funds with a statement that the resources of the state (or territory), including moneys which are then available and which can be made available by the state or territory, its political subdivisions and by private contributions, are inadequate to meet its relief needs. Debt limitations of states and municipalities are not a bar to obtaining loans under this section.

Title II provides for loans to states and municipalities and to private corporations under certain conditions, for self-liquidating construction projects. At one stage of its development the act provided $1,500,000,000 debentures of the Reconstruction Finance Corporation for this purpose. As finally passed, however, all the resources of the Reconstruction Finance Corporation, excepting the $300,000,000 provided under Title I for direct relief, are thrown into one pool aggregating $3,500,000,000. No specific amount is allotted for any particular purpose. The loans already made by the Reconstruction Finance Corporation to railroads and banks aggregate over $1,000,000,000. There is, therefore, no assurance that the entire amount of $1,500,000,000 will be available for construction loans. On the other hand, should the needs of banks and railroads decrease or should repayment be made by them, the amount available under Title II for construction projects might be greater than $1,500,000,000.

The five types of agencies to which loans are made available for construction under Title II are as follows:

1. States, municipalities, and political subdivisions for specific construction projects.
2. Housing corporations which are regulated by the state or by municipalities.
3. Private corporations to aid in carrying out the construction, replacement, or improvement of bridges, tunnels, docks, viaducts, water works, including industrial water supply systems, canals, and markets devoted to public use.
4. Private corporations for the development of forests and other renewable natural resources which are regulated by the state.
5. States, municipalities, or other public body for publicly owned bridges to be used for railroad, railway, and highway purposes, the cost of which will be returned in part by means of tolls, fees, rents, or other charges, and the remainder by means of taxes imposed pursuant to state law enacted before the date of enactment of the Emergency Relief and Construction Act of 1932.

It is required that all of these projects be self-liquidating in character. The definition of this term is as follows:

> For the purposes of this subsection a project shall be deemed to be self-liquidating if such project will be made self-supporting and financially solvent and if the construction cost thereof will be returned within a reasonable period by means of tolls, fees, rents, or other charges, or by such other means as may be prescribed by the statutes which provide for the project other than by taxation.

This definition of "self-liquidating" is subject to interpretation. At one time the language in the bill broadened this definition. As enacted, however, there is a question as to whether the allocation of certain revenues to service charges on the securities would be barred by the present definition. An early ruling on this point should be sought as the matter affects vitally both water and sewage works, such a ruling to determine what steps would be necessary to make either or both of these eligible under the definition of the law.

Normal loans of the Reconstruction Finance Corporation may be made for a period not exceeding three years with renewal for not more than two years, making the total period five years. For all the foregoing types of projects, however, loans may be made for a period not exceeding ten years. For Nos. 1 and 5 only, the Reconstruction Finance Corporation is authorized to purchase the securities of states, municipalities, and political subdivisions which may have

FEDERAL CREDIT FOR PRODUCTIVE PUBLIC WORKS,

Resolution of May 9, 1932

Resolved, That the American Society of Civil Engineers, through its Executive Committee,

1. Approves in principle a normal program of public works construction as the most effective immediate means of increasing purchasing power, stimulating trade recovery and reviving employment; and

2. Urges on the Congress of the United States the enactment of the necessary legislation to extend Federal credit facilities to solvent states, counties and municipalities to enable them to carry out their normal programs of necessary and productive public works.

a maturity of more than ten years. The language under No. 1 is broad enough to include joint authorities, drainage districts, sewer or water districts, and any conceivable combination of state or municipality.

The interest rates which will be charged by the Reconstruction Finance Corporation are left entirely to its judgment. Most of the loans heretofore made to railroads and banks have been at 6 per cent. As the Reconstruction Finance Corporation is at present obtaining all of its funds through the sale of short-term Treasury obligations at average rates of under 2 per cent, it would seem that the corporation would be amply justified in requiring from states and municipalities only rates of interest which would be applicable to the various classes of these securities in normal times. In this respect, the tax-exemption privilege undoubtedly will be taken into account. This privilege in normal times has been estimated at from 3/4 per cent to 1 per cent and its value has been accentuated recently by increased income taxes in the higher brackets.

Other provisions of Title II which are of general interest are:

The provisions apply to territories and Puerto Rico;

Loans may be made at any time up to January 23, 1934;

No fee or commission shall be paid for loans—this does not prevent payments for services to engineers and lawyers;

Not more than $100,000,000 shall be loaned for any one project;

No convict labor shall be directly employed and (except in executive, administrative, and supervisory positions), so far as possible, no individual directly employed shall be permitted to work more than 30 hours in any one week. Preference is to be given, when they are qualified, to ex-service men with dependents;

Provision is made for loans to financial institutions, corporations, and railroads, eligible under the act establishing the Reconstruction Finance Corporation, for new construction work which will create employment;

Loans may be made for the marketing of surplus agricultural products;

Provision is made for the organization of 12 Federal Land Banks with a paid-up capital of not less than $3,000,000 to be subscribed for by the Reconstruction Finance Corporation. These corporations are authorized to make loans or advances to farmers and stockmen for agricultural purposes or for the raising, breeding, fattening, or marketing of livestock;

The new Reconstruction Finance Corporation will consist of the Secretary of the Treasury and six other persons. The chairmen of the Federal Reserve Bank and of the Farm Loan Board have been eliminated; and

Loans to private individuals may be made by the Federal Reserve Board on securities now eligible for discount from member banks.

Under Title III are included Federal public works, totaling $322,000,000, to be financed by the Treasury. Of this $120,000,000 is to be loaned to states to meet their appropriations matching the Federal road aid and must be expended before July 1, 1933. The amount so advanced is to be paid back to the Federal Government over a period of ten years, beginning in 1938, by deductions from the regular Federal road aid apportionments, unless repaid directly. The total appropriated for Federal road aid this year is $125,000,000, from which $16,000,000 has been deducted for former advances, leaving a total of $109,000,000 to be matched by the states. Authorization for Federal aid beyond July 1, 1933, failed of passage at this session but will come up again in December. There is also appropriated $16,000,000 for highway work in national forests and parks.

The remainder of the $322,000,000 for Federal public works is divided as follows:

River and harbor projects	$30,000,000
Flood control	15,500,000
Hoover Dam	10,000,000
Air and navigation facilities	500,000
Lighthouse service	3,810,000
Engineering Work of the Coast and Geodetic Survey	1,250,000
Yard and docks—Navy Department	10,000,000
Public buildings outside of District of Columbia	100,000,000
Housing and other facilities at Army posts	15,164,000

Except for the army posts which are listed, the projects under the other categories are to be selected by the administration.

With the exception of the $136,000,000 for roads, no portion of this appropriation for Federal public works shall be expended if the Secretary of the Treasury certifies to the President that the amount necessary for such expenditure is not available and cannot be obtained upon reasonable terms.

Secretary's Abstract of Board of Direction Meeting, July 4 and 5

THE BOARD OF DIRECTION met at Yellowstone National Park on July 4 and 5. Present were Herbert S. Crocker, President; George T. Seabury, Secretary; and Messrs. Black, Buck, Chester, Coleman, Dusenbury, Enger, Gregory, Henny, Herrmann, Hoffmann, Holleran, Lupfer, MacCrea, Mead, Mendenhall, Riggs, Singstad, Charles H. Stevens, J. C. Stevens, Stuart, Thomas, and Tuttle.

"Engineers Council for Professional Development"

A plan, or program, calling for a continuing joint movement by engineers to coordinate and promote efforts and aspirations directed toward higher professional standards of education and practice was approved. The plan was submitted by a group composed of three representatives from each of a number of engineering organizations.

An immediate objective proposed is the development of a system whereby the progress of the young engineer toward professional standing can be recognized by the public, by the profession, and by the man himself, through the development of technical and other qualifications which will enable him to meet minimum professional standards. The full report of the 21 representatives of the seven organizations will be found elsewhere in this issue. The Society's representatives were J. Vipond Davies, Harrison P. Eddy, and Charles F. Loweth, Members Am. Soc. C.E.

Practical Engineering Work for Non-Graduates and Postgraduates

The Board broadened the rules in reference to applicants for admission and transfer so as to grant credit for practical engineering work performed by non-graduates during their vacations, or as part of their engineering course, and for the engineering work performed by postgraduate students.

Federal Control Survey Program

Basing its action on considerations of economy and sound public policy, the Board endorsed the resolutions adopted by the Society's Division of Surveying and Mapping, supporting the program of the U.S. Coast and Geodetic Survey to establish and make available at the earliest practicable date, controlling triangulation with the arcs spaced at intervals averaging not more than 25 miles throughout the United States.

The Federal system of triangulation control provides the framework which supports surveys for lines of communication, real property boundaries, political boundaries, local triangulation systems in metropolitan areas, topographic mapping, and large construction operations. The endorsement of the resolution was given in the belief that this principal triangulation control must be accepted as a national responsibility to be prosecuted under a single organization.

The resolution follows:

WHEREAS, The present program of the United States Coast and Geodetic Survey contemplates the establishment of controlling survey positions resulting from arcs of first-order triangulation spaced at intervals of approximately one hundred miles throughout the United States, and of similar positions resulting from arcs of second-order triangulation located approximately half-way between these; and

WHEREAS, The requirements of present engineering practice incident to the proper development of the nation demand that such controlling triangulation survey positions be made available in approximately twice the amount and frequency contemplated in the present program; now, therefore,

Be it further resolved, That the Board of Direction of the American Society of Civil Engineers does hereby petition the President of the United States to direct that the program of the United States Coast and Geodetic Survey be such as to establish and make available at the earliest practicable date

controlling triangulation with the arcs spaced at intervals averaging not more than 25 miles throughout the United States; and

Be it further resolved, That the President be hereby apprized of the urgent and immediate need of this action, in order that such states as have appropriated, or may soon appropriate, supplementary funds for the completion of the triangulation within their borders may secure these additional stations while the survey is in progress.

Secretary, Treasurer and Assistant Treasurer Reelected

In accordance with the By-Laws, the Board elected a Secretary, a Treasurer, and an Assistant Treasurer. The present incumbents were reelected, as follows: Secretary, George T. Seabury; Treasurer, Otis E. Hovey; Assistant Treasurer, Ralph R. Rumery.

Two Freeman Traveling Scholarships This Year

Endorsing the recommendations of the Freeman Fund Committee, the Board awarded two traveling scholarships this year, one to Herbert H. Wheaton, Assoc. M. Am. Soc. C.E., of Berkeley, Calif., who is just completing work for the professional degree of C.E. at the University of California; and another to Donald P. Barnes, Jun. Am. Soc. C.E., instructor in the Department of Civil Engineering, School of Mines and Metallurgy of the University of Missouri, at Rolla, Mo. Each scholarship consists of a gift of $1,600 for expenses during a year's study in the hydraulic laboratories of Germany.

Horatio Allen Scholarship at Columbia University

Approving the recommendation of the Columbia University Scholarship Committee, the Board awarded the Horatio Allen Scholarship to J. Gordon Lippincott, Jun. Am. Soc. C.E., of White Plains, N.Y. Mr. Lippincott graduated from Swarthmore College in 1931, with the degree of B.S. in Civil Engineering.

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President H. S. Crocker was appointed to the John Fritz Medal Board of Award.

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Approval was given to the formation of a new Local Section of the Society to be known as the Indiana Section. The Society now has 56 Local Sections.

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Approval was given to the organization of two Student Chapters, one at the Louisiana State University, and another at Rhode Island State College, making a total of 103 Student Chapters.

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The Board gave consideration to three instances of alleged unprofessional conduct.

Engineers' Unemployment Relief

The Board authorized the Secretary to continue to carry out the measures undertaken for the relief of unemployed engineers which were instituted by the Board's action of last October, upon recommendation of the Society's Committee on Salaries.

Model Registration Law

The Board approved and adopted the Model Registration Law.

Under instructions from the Board, the Society's Committee on Registration of Engineers called a conference of representatives from interested engineering societies on April 15, 1932, thirteen societies being represented. The action of the conference was to revise the Recommended Uniform Registration Law, which model law the committee submitted to the Board for appropriate action.

The action of the Board was to adopt and endorse the proposed law; to authorize its dissemination among other interested groups; to recommend it as a model law to be adopted by states which have no registration law; and to recommend the incorporation of the provisions of this law in future amendments to existing laws.

The full text of the model law is reproduced in full elsewhere in this issue.

Normal Program for Public Works

It was reported that the Committee on Public Works had devoted its attention primarily to two activities in its efforts to make operative in fact the resolution adopted on May 9 by the Executive Committee of the Society with regard to "A Normal Program of Public Works to Stabilize Industry and Increase Employment."

The committee assisted in the drafting of the Wagner Bill, as passed by the Senate, and urged the Local Sections to support it. The committee also, with the aid of the Local Sections, accumulated data with respect to state, county, and municipal public works held in abeyance for lack of funds, to an amount exceeding $3,000,000,000. These data have been made available to the members of Congress and to the President of the United States.

The Board expressed warm appreciation of the efforts of the committee

Administrative Details

The Board devoted considerable time to administrative details, including a consideration of the matter of arrearage in dues.

Adjournment

The Board adjourned to meet at Atlantic City, N.J., October 3, 1932.

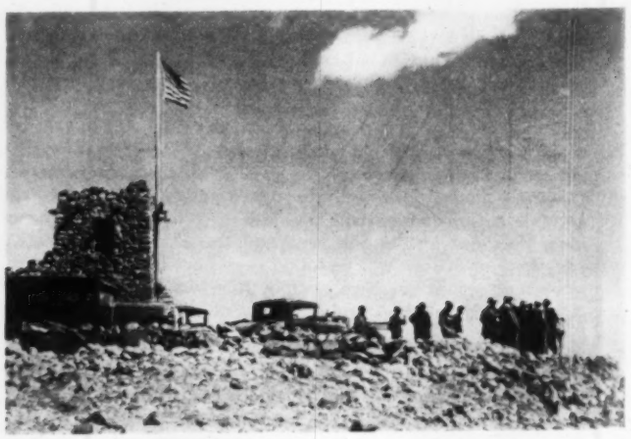
Society Meeting in Geyserland

Convention at Yellowstone Park a Great Success

A SOCIETY MEETING in a great national park may be an innovation but the success of the one held at Yellowstone Park on July 6, 7, and 8 was more than a justification for the novelty. The very remoteness from urban centers, the charm and wonder of nature so well interpreted by the rangers of the National Park Service, and the assistance cordially rendered by the Park administrative staff and by the hotel, lodge, and camp managements, all contributed to make this a unique and memorable Convention. A total registration of 250 persons bore final witness to the popularity of the meeting; and in these parlous times, that witness was eloquent.

The Convention was preceded by the usual meeting of the Board of Direction, held on this occasion at Mammoth Hot Springs in

A VANTAGE POINT AT THE LOWER FALLS



A GROUP ON MT. WASHBURN; ELEVATION 10,317 FT.

SOCIETY MEMBERS, PARK OFFICIALS, AND GUESTS AT THE YELLOWSTONE ANNUAL CONVENTION, JULY 1932
A Stop at Fishing Bridge Camp Museum on Lake Yellowstone En Route to the Canyon, on the Friday Trip

the Park. The members of the Board, accompanied by a number of other members of the Society, had previously attended the rodeo at Livingston, Mont., and spent the night at Hunter's Hot Springs, arriving in the Park on Monday noon.

The Board sessions occupied the rest of the time until Tuesday afternoon, when the party took buses for Old Faithful Inn. Stops were made at geyser basins, warm springs, Obsidian Cliff, and other fascinating spots en route, under the guidance of ranger naturalists of the National Park Service.

CONVENTION SESSIONS

The Convention itself opened at Old Faithful Inn on Wednesday, July 6, and conformed precisely to the program as published in the June issue of CIVIL ENGINEERING, except that several speakers and authors were unable to be present in person and their papers were presented by substitute readers. President Crocker responded to greetings from representatives of the Governor of Wyoming and of the Secretary of the Interior, and then read his own Annual Address to the Society, entitled "Some Reflections Regarding Engineering Practice." This was followed by a paper on "The National Parks and Their Improvement."

In the afternoon two papers were presented—"The Rise and Fall of the Public Domain" and "Forests and Stream Flow." Excellent attendance, animated discussion, and sustained interest testified to the appropriateness of these subjects.

On Wednesday evening, practically the entire party ate dinner together in Old Faithful Inn, more than 190 places being occupied. Considering the competitive attraction of watching the bears at their evening feeding, this was an unusually complete attendance out of the total registration at the Convention. The dinner was followed by a most informative illustrated talk on the geology of Yellowstone Park, by Prof. Richard M. Field, Professor of Geology at Princeton University.

TECHNICAL DIVISIONS ENJOY PROGRAMS

On Thursday morning there were joint sessions of the Highway and Structural Divisions and of the Irrigation and Power Divisions. The former group considered the subjects, "Western Highway Bridge Practice" and "Roads in the National Parks," while the latter group devoted the morning to "The Development of the Columbia River," with attendant discussion.

In the afternoon both of the joint sessions were continued, taking up "Steel Pile Foundations for Highway Bridges" and "New Types of Reinforced Concrete Highway Bridges," and "Effect of Uplift on Stability of Straight Gravity Dams," "Duty of Water in Terms of Canal Capacity," and "Tests for Hydraulic-Fill Dams," respectively. In addition, the Construction Division saw motion pictures on the "Construction Equipment of Hoover Dam" and listened to a paper on "Construction Methods on the Cle Elum Dam." As on the previous day, these sessions were well attended, and the discussion was stimulating. Motion pictures and slides were used to illustrate the majority of the papers and discussions.

With the close of these sessions on Thursday, the members were free to visit the bear-feeding grounds, to wander among the hot springs and geysers, to fish for trout in the Firehole River, or merely to sit on the porch and enjoy the invigorating weather which favored the Annual Convention.

TIME FOR SIGHT-SEEING

On Friday morning, an all-day excursion commenced by bus over the Continental Divide to Yellowstone Lake and the canyon of the Yellowstone River. A brief stop was made at the fish hatchery on the lake, where the methods of propagation were demonstrated, and the fishing instincts of most of the members were stirred by the sight of hundreds of fine trout in the lake.

After lunch at the Canyon Hotel the party visited points of vantage around the Canyon of the Yellowstone under the guidance of Dr. Field and the ranger naturalists of the Park Service, stops being made to enjoy the view, to take photographs, or for the more serious discussion of the geological history of the area. After a night spent at the Canyon Hotel, a smaller group went on to Roosevelt Lodge, stopping en route to inspect evidence of prehistoric lava dams across the gorge at Tower Falls and to discuss interesting geological problems involved in the relocation of the highway at that point. At Roosevelt Lodge the party relaxed from the intensity of a full week, and assisted the lodge staff in their concert and entertainment during the evening. Side trips were made during the afternoon to the petrified forest, along nature trails, and to streams where the fishing was good.

Next morning the party started by bus on their reluctant way out of the Park to entrain at Cody, Wyo., a stop being made at Shoshone Dam, where representatives of the U.S. Reclamation Service explained the details of the dam and power equipment, and conveyed many of the members out over the Shoshone Irrigation Project.

SUCCESS WARRANTS REPETITION

This innovation of holding a Society meeting in a National Park seems destined for repetition in the future if the comments of those who attended are given due consideration. In spite of pleasant distractions such as the Mammoth Hot Springs, Old Faithful, and its attendant geysers, wild game met at frequent intervals along the roads and trails of the park, the beautiful expanse of Yellowstone Lake, the wonders of the Canyon, and everywhere the temptation to wander at will over this vast playground, the sessions of the Convention were far from neglected. For example, attendance counts at various meetings were as follows:

Wednesday morning	200
Wednesday afternoon	125
Wednesday evening	190
Thursday morning	
Highway-Structural	40
Irrigation-Power	45
Thursday afternoon	
Highway-Structural	32
Irrigation-Power	22
Construction	45

It was estimated that about 50 went on the all-day excursion on Friday, while 21 continued on to Roosevelt Lodge.

Those in attendance at this convention will long remember the cordial welcome extended by the staff of the National Park Service and the continuous assistance rendered by the ranger force. Several of the latter accompanied the party throughout its tour, and cordial cooperation was extended by every member of that force with whom the party came in contact. Thanks in particular are due to Professor Field for his organization and conduct of the geological features of the trip.

Atlantic City Meeting Shows Great Promise

AS PLANS MATURE for the Fall Meeting of the Society, to be held at Atlantic City, October 5–8, enthusiasm for the excellent prospects of this gathering of Society members grows rapidly. No stone seems to have been left unturned to add to the value of the Meeting or to the enjoyment of those who will convene at this noted shore resort in the fall.

Because of the nature of the Meeting and its locale, four days are to be devoted partly to engineering meetings and partly to social events. In all, four sessions will be given over to technical papers and discussion, those in the morning and afternoon of Wednesday, and in the morning on Thursday and Friday. The free afternoons will be reserved for the enjoyment of the recreations that only one of the largest and best appointed of Atlantic shore resorts can offer. The balance between work and play will be further maintained by devoting the evenings to sociability in and about the Meeting headquarters.

Members who enjoy the exhilaration of the sea at its best will doubtless wish to spend an extra week-end at Atlantic City. In this case they may desire to plan to arrive a few days before the Meeting proper begins. On Monday and Tuesday, October 3 and 4, the Society's Board of Direction will be in session for its quarterly meeting. This group with their families will form a nucleus of friends and acquaintances to add to the pleasure of those arriving early.

COMPREHENSIVE TECHNICAL PROGRAM

The Meeting itself will be called to order on Wednesday morning, October 5. After addresses by local and state officials, there will follow a short general meeting, featuring the extensive terminal and other improvements in the central part of the city of Philadelphia. Following lunch, the general session will be continued through Wednesday afternoon, dealing with the Regional Plan of the Philadelphia Tri-State District.

In all, five Technical Divisions are planning to meet at Atlantic City. Their sessions are scheduled for Thursday and Friday mornings. On Thursday the Sanitary Engineering Division will hold an independent session, while the City Planning and the Surveying and Mapping Divisions meet jointly. For Friday morning, the Sanitary Engineering Division, the Highway Division, and the Engineering-Economics and Finance Divisions have scheduled programs. Ample time is thus allowed, without too much overlapping, for worthwhile Division meetings. A fine array of topics by well known speakers is in prospect.

AMPLE TIME FOR OTHER ENJOYMENT

This arrangement leaves two afternoons and three evenings free for recreational activities—a phase of life at Atlantic City that has been cultivated to perfection. A golf tournament has been planned for Thursday afternoon, and doubtless numerous independent matches at other times will be arranged as the program permits or individual inclination dictates. For lovers of the game, one of the finest and most complete clubs in the East is available—the Seaview Golf Club. Guest privileges will be extended to all members and friends. The club is within easy reach of Atlantic City and boasts one of the most commodious clubhouses in the region. Golf, under such delightful surroundings, with excellent facilities and a commanding location, leaves little to be desired. The magnificent clubhouse will also provide a center for many of the ladies' activities during the Meeting.

Atlantic City is also noted for its fishing and boating. Parties can readily be made up for either sport, at any time of day and for as long as required. Many of the local members, who have often availed themselves of these opportunities, will be glad to give all the necessary advice and assistance.

According to the tentative program, a formal dinner is scheduled for Wednesday evening. Leaders in industrial and engineering enterprises of great magnitude have agreed to be present and to take part in the post-prandial exercises. The President of the Society will preside.

A special event for the ladies has been scheduled for Thursday in the form of a luncheon and bridge at the Seaview Golf Club. That same evening there will be a reception, entertainment, and dance at the hotel.

Headquarters, Technical Meetings, lunches, and dinners, will be at the Chalfonte-Haddon Hall Hotel. To those who are familiar with Atlantic City, this choice of a noted hostelry is immediate guarantee of the best attainable service. The hotel has a fine record for amply taking care of conventions, notably in the case of the American Society for Testing Materials, which has returned repeatedly and exclusively to this hotel. The rooms are commodious and varied to suit every purse; the cuisine is noted for its excellence. Special prices have been quoted, on either the American or European plan. This arrangement promises the best of service at reasonable cost. The Committee on Arrangements considers that it has been very fortunate in being able to make such favorable reservations.

THE SOCIETY MEETS IN ATLANTIC CITY OCTOBER 5–8, 1932

To speak of the Atlantic City boardwalk is to mention a promenade that is known throughout the world. There everybody meets. Whether it be to stroll, to shop, to chat, or simply to enjoy the ocean air, the boardwalk is the recognized place. It is an institution, which never seems to lose its popularity.

In suggesting this meeting place for the first week in October, the committee sought to obtain what many people consider ideal

conditions. Although no guarantee can be made as to weather, it is recognized by those who are most familiar with the locality that this season is ideal for a meeting. Usually the air is mild at this season; always it is invigorating. Furthermore, the peak of the summer visitors has passed and accordingly the city and beach are less crowded. The real lover of Atlantic City can enjoy it in greater freedom and comfort.

In addition, the chances are that bathing will be both pleasant and popular. At this time as a rule the water is still sufficiently warm and, providing the air is mild, the sport can be enjoyed without discomfort. In fact, many swimmers prefer it at this time. In any event, sun bathing is bound to be popular.

Doubtless many guests will come to Atlantic City by automobile. They will find every accommodation. During the Meeting, ample time will be available for touring if desired. From Cape May, on the southern tip of the state, to Asbury Park and Sandy Hook on the north, the shore roads are attractive. In the interior of the state also there are delightful drives in abundance. Within easy driving distance is Lakehurst, famous naval air station, where the *Akron* and other lighter-than-air craft are housed.

TO ENJOY FULL DAY IN PHILADELPHIA

As a finale for the Meeting, a gala excursion has been planned for Saturday, October 8. Leaving by train and automobile, the party will proceed to Philadelphia, where the morning will be spent in trips to points of interest throughout the city. Included in this excursion will be a visit of special value to all engineers, covering the extensive improvements in the terminal and approaches of the Pennsylvania Railroad in the heart of Philadelphia. All these morning trips will end at the new station, where a complimentary luncheon will be served. Early in the afternoon, buses will convey the entire group to visit Valley Forge and interesting points on the way. This trip to one of the famous localities in American Colonial history will take the party through some of the most picturesque parts of Pennsylvania. It should form a fitting close to the Atlantic City Meeting.

Although these arrangements are not final in every instance, it is expected there will be only minor changes. Details of subjects and speakers, of meeting and entertainment schedules, and all the other minutiae required by the member who expects to attend must await the official program. This is expected to appear in the September issue of CIVIL ENGINEERING, giving notice sufficiently in advance so that definite plans for attending may be made with assurance. For answers to questions regarding details of the Atlantic City Meeting, October 3–8, reference should therefore be made to the official program published next month.

Engineers' Council for Professional Development

The following plan for joint action has been proposed by the Conference on Certification into the Profession, a body made up of representatives of the American Society of Civil Engineers, the American Institute of Mining and Metallurgical Engineers, the American Society of Mechanical Engineers, the American Institute of Electrical Engineers, the American Institute of Chemical Engineers, the Society for the Promotion of Engineering Education, and the National Council of State Boards of Engineering Examiners.

1. General Objective

The general objective of the proposed joint movement is the enhancement of the professional status of the engineer. To this end, it aims to coordinate and promote efforts and aspirations directed toward higher professional standards of education and practice, greater solidarity of the profession, and greater effectiveness in dealing with technical, social, and economic problems.

2. Immediate Objective

An immediate objective, now apparently practicable of attainment, is the development of a system whereby the progress of the young engineer toward professional standing can be recognized by the public, by the profession, and by the man himself, through the development of technical and other qualifications which will enable him to meet minimum professional standards.

3. Joint Action

These objectives can best be attained through the whole-hearted cooperative support of those national organizations directly representing the professional, technical, educational, and legislative phases of an engineer's life, namely, the American Society of Civil Engineers, the American Institute of Mining and Metallurgical Engineers, the American Society of Mechanical Engineers, the American Institute of Electrical Engineers, the American Institute of Chemical Engineers, the Society for the Promotion of Engineering Education, and the National Council of State Boards of Engineering Examiners.

The movement can go forward effectively only under the administration of a joint committee. It is suggested that this committee be made up of three representatives of each constituent body.

4. Name

The name of the joint agency should indicate clearly the universal character of the movement and its objective. It is suggested that the joint committee be named "Engineers' Council for Professional Development."

5. Operation

The "Engineers' Council for Professional Development," if and when constituted, shall from time to time recommend to the governing boards of the several cooperating organizations procedures considered to be of value or significance in promoting the general objective set forth, and shall administer such procedures as shall have been approved by those boards.

RECOMMENDATION

The Conference on Certification, having duly considered the foregoing, has unanimously adopted it and recommends to the organizations thereon represented that they approve the plan as outlined and appoint three representatives each to the proposed "Engineers' Council for Professional Development."

PROPOSED INITIAL PROGRAM

The Conference on Certification recognizes certain procedures which may be undertaken by the Engineers' Council for Professional Development immediately after its organization, and in view of the infrequent and scattered meetings of the governing bodies of the organizations here represented it suggests that if these bodies act as above recommended they also authorize Council to proceed with the following program:

First, to develop further means for the educational and vocational orientation of young men with respect to the responsibilities and opportunities of engineers, in order that only those may seek entrance to the profession who have the high quality, aptitude, and capacity which are required of its members;

Second, to formulate criteria for colleges of engineering, which will ensure to their graduates a sound educational background for practicing the engineering profession;

Third, to develop a program for the further personal and professional development of young engineering graduates and a program for those without formal scholastic training;

Fourth, to develop methods whereby those engineers who have met suitable standards may receive corresponding professional recognition.

Official Meeting Programs

APPARENTLY there persists some misunderstanding as to the form in which the official programs of Society Meetings are now issued. The separate leaflet, sent by mail to each member individually, is now a thing of the past, and in its place the program is given only in CIVIL ENGINEERING, where it is incorporated in an issue appearing sufficiently far in advance of the meeting itself. Those members who have expected and waited for the independent program have therefore been disappointed.

This arrangement has the virtue of including the final program in an official Society record, where it can be maintained permanently. In addition, it avoids the expense of filling and mailing individual envelopes. It has been in vogue since the issue of last January when the official program of the Annual Meeting was presented. Subsequently, the program of the Yellowstone Convention was included in the June issue, and that of the coming Fall Meeting at Atlantic City is expected to appear in the September number of CIVIL ENGINEERING.

Reprints of official programs in folder form are available in advance of a meeting and are issued to those in attendance. Most members have found that the present method of printing in CIVIL ENGINEERING fills every need.

Charles Warren Hunt

1858–1932

AFTER A PROLONGED illness, Charles Warren Hunt, Member and Secretary Emeritus of the Society, died on July 23 at the Engineer's Club, New York, N.Y. Born May 19, 1858, he attended private schools and New York University, where he graduated in 1876 in Civil Engineering as valedictorian of his class. In 1909 his alma mater conferred on him the honorary degree of doctor of laws. Although his father was a lawyer and he had inherited a keen analytical mind, the law did not appeal to him. Instead he immediately entered engineering practice, making brief essays in several fields—governmental service on river and harbor work, city employ in the Brooklyn Parks and New York Dock Department, and water works engineering as chief engineer of the New Rochelle Water Works.

CHARLES WARREN HUNT

For a number of years he was connected with the engineering offices of Charles B. Brush, M. Am. Soc. C.E., and J. James R. Croes, Past-President Am. Soc. C.E., both well known members of the Society at that time. Thus Dr. Hunt became familiar with the organization and its ideals. This path led in due course to his appointment in 1892, while he was still a young man, as Assistant Secretary and Librarian of the Society under Francis Collingwood, then Secretary. Shortly afterward Mr. Collingwood gave up the increasing responsibilities and activities of administering the growing Society. In his place Dr. Hunt was promoted to the Secretaryship, in 1895.

Thus at the age of 37 he became executive head of the oldest national engineering Society in America. And for 25 years he held this position, throughout the heydey of his professional activity. The Society became his life, deserving and receiving his best endeavors. During this time he saw it grow from a membership of only 1,900 in 1895 to that of 9,400 in 1920; and correspondingly in importance.

It was not in its size only that Dr. Hunt's efforts were reflected. The Society's resources and influence among engineers also mounted. When he began his work the organization had headquarters in a building on West 23d Street, which though small was ample at that time. Before long these offices seemed crowded and more commodious quarters were needed to meet the requirements of the growing organization. Dr. Hunt foresaw the northward growth of the city and advised the purchase of property on West 57th Street. This acquisition was made and a Society house was built and occupied with fitting ceremony on November 24, 1897. Later it was expanded by the purchase of an additional lot on which a building was erected. This was completed in 1905 and first used for the Annual Meeting in January 1906. These offices sufficed for 20 years, or until 1917, when the Society joined with the other Founder Societies in its present quarters.

All these advances were made during Dr. Hunt's incumbency. How well his judgment has been vindicated and his planning borne fruit has been emphasized in recent years, for the 57th Street property has been yielding a handsome return on the Society's investment.

Among the means emphasized by Dr. Hunt for increasing interest in Society activities was the holding of technical meetings. Semimonthly gatherings at the Society house were the rule, except during the summer. These meetings are still well remembered, especially by the older members. He also believed strongly in the Society Meetings held elsewhere, particularly in the Annual Convention. Dr. Hunt was fond of recalling some of the most picturesque of these, such as the International Engineering Congress sponsored by the Society in connection with its convention held at the St. Louis Exposition in 1904; the celebrated convention held in Mexico City in 1907; and the International Engineering Congress at the Panama Pacific Exposition in San Francisco in 1916.

This same interest showed itself in technical publications. As an outgrowth of the St. Louis Convention the Society published a noteworthy set of papers, included in six volumes of TRANSACTIONS. In these Dr. Hunt took a personal interest and a great deal of pride.

He visualized the Society library as a living and useful tool. It had to be up to date, efficient, and always available. He felt that one of the strongest incentives to moving into the present headquarters was the opportunity of merging facilities to create the most important technical library in America. From this same interest came Dr. Hunt's regard for the Society's own technical publications. This phase of his work as Secretary is attested by the notable set of TRANSACTIONS, Vols. 26 to 83, published under his general direction.

His interest and pride in the Society is further attested by his writings on its history. In 1897, his *Historical Sketch of the American Society of Civil Engineers: 1852–1897* was published and sold in book form, and the proceeds were applied to the 57th Street property fund. At the Annual Convention in Washington, D.C., May 20, 1902, he delivered an address outlining briefly *The First Fifty Years of the American Society of Civil Engineers: 1852–1902*, published in TRANSACTIONS, Vol. 48. In 1918 he brought these historical records up to date in his paper on "The Activities of the American Society of Civil Engineers During the Past Twenty-Five Years," which was published in TRANSACTIONS, Vol. 82.

No member who came into contact with Headquarters during this time could fail to realize its high efficiency. Dr. Hunt was a stickler for form and yet he inculcated in every member of the staff a vigorous sense of pride in the Society. No better evidence can be adduced than the continued enthusiastic service of that same staff.

Because of his long association with the profession in a position of the highest authority and responsibility, he became well known in engineering circles throughout the country. Any mention of his personal attributes would therefore be superfluous. Dr. Hunt was gifted with a brilliant mind and a versatile pen. His judgment was unusually sound, and he supported it with pointed, forceful argument. He could draft the most polished letter, or, if occasion demanded it, the most withering criticism. As a raconteur he was at his best. His comments were pithy, his appreciation of the foibles of humanity was keen, and his wit illuminated every narrative.

Since his retirement as Secretary in 1920, his activities have been much hampered by ill health. However, when in the city he made daily visits to Headquarters and was often to be seen at the adjoining Engineer's Club with one or another of his coterie of friends. For many years he was a member of the St. Andrews Golf Club and his skill is shown by the numerous cups and prizes that he won. At one period, also, he served as secretary of the United States Golf Association. During recent years, however, he was compelled to forego this game. In his younger days he enjoyed fishing and shooting, and as long as his health and strength permitted, he was an enthusiastic motorist.

Subsequent to his attendance as Society representative at the 80th anniversary of the Koninklijk Instituut van Ingenieurs in Holland in 1922, he was made an Honorary Member of that organization. He was also a member of the Order of Colonial Lords of Manor in America.

Funeral services were held on Monday afternoon, July 25, in St. Agnes Chapel, West 92d Street. A large group of present and former Society officers, as well as a representative number of the staff of Headquarters, particularly those who had been associated with Dr. Hunt, were in attendance. Interment was private, in Woodlawn Cemetery.

Mrs. Hunt, who was well known among the older group that frequented Society Meetings, was in constant attendance during his final illness. In addition he is survived by a son, Charles Warren Hunt, Jr., of San Francisco, and a daughter, Alice Riggs Hunt, of New York.

In his every thought and action pride in the Society and its work was uppermost. This high idealism was reflected in the staff. On his retirement, he left this spirit behind him and it still persists as a heritage of the notable régime of Dr. Charles Warren Hunt

A Model Law for the Registration of Professional Engineers and Land Surveyors

In the Form Now Adopted and Endorsed by the Board of Direction

FOR years the question of registration laws for engineers has been under consideration by the profession. Active work on this subject was renewed in 1929 when the Society's Committee on Registration of Engineers formulated a draft of a model law. During succeeding years and with the cooperation of many other engineering organizations, the proposed uniform law was revised and perfected. Finally, in April 1932, after discussion submitted by national, state, and local organizations of engineers, a conference representative of the interested organizations called at the instance of the Society's committee felt that their efforts were completed. The conference, therefore,

"RESOLVED, To recommend the adoption of this Model Law for the Registration of Professional Engineers and Land Surveyors by all national, state, and local organizations of engineers as a model to be followed in the framing of all new registration laws and the amending of existing laws, with a view to attaining a uniform high standard throughout the United States."

In this form the law was submitted to the Society's Board of Direction at its meeting on July 4 and was adopted and endorsed. The proposed model law in its entirety is reprinted here for the information and benefit of members at large. In addition, pamphlet reprints of the law and the historical résumé of its formulation are available on request from Society Headquarters. The present Society Committee on Registration of Engineers is made up of the following personnel: T. Keith Legaré, Chairman, L. L. Hidinger, R. E. Warden, W. T. Chevalier, and Ole Singstad, Members Am. Soc. C.E.

AN ACT to regulate the practices of professional engineering and land surveying; creating a State Board of Registration for Professional Engineers and Land Surveyors; defining its powers and duties; also imposing certain duties upon the State and political subdivisions thereof in connection with public work; and providing penalties.

Section 1.—General Provisions.—Be it enacted by the General Assembly of the State of.....that in order to safeguard life, health, and property, any person practicing or offering to practice the professions of engineering or of land surveying, shall hereafter be required to submit evidence that he is qualified so to practice and shall be registered as hereinafter provided; and it shall be unlawful for any person to practice or to offer to practice the professions of engineering or of land surveying, in this State, or to use in connection with his name or otherwise assume, use, or advertise any title or description tending to convey the impression that he is a professional engineer or a land surveyor, unless such person has been duly registered or exempted under the provisions of this Act.

Section 2.—Definitions.—The term "professional engineer" as used in this Act shall mean a person who, by reason of his knowledge of mathematics, the physical sciences, and the principles of engineering, acquired by professional education and practical experience, is qualified to engage in engineering practice as hereinafter defined.

The practice of professional engineering within the meaning and intent of this Act includes any professional service, such as consultation, investigation, evaluation, planning, design, or responsible supervision of construction or operation, in connection with any public or private utilities, structures, buildings, machines, equipment processes, works, or projects, wherein the public welfare, or the safeguarding of life, health, or property is concerned or involved, when such professional service requires the application of engineering principles and data.

The term "land surveyor" as used in this Act shall mean a person who engages in the practice of land surveying as hereinafter defined.

The practice of land surveying within the meaning and intent of this Act includes surveying of areas for their correct determination and description and for conveyancing, or for the establishment or reestablishment of land boundaries and the plotting of lands and subdivisions thereof.

The term "Board" as used in this Act shall mean the State Board of Registration for Professional Engineers and Land Surveyors, provided for by this Act.

Section 3.—State Board of Registration for Professional Engineers and Land Surveyors.—Appointment of Members.—Terms.—A State Board of Registration for Professional Engineers and Land Surveyors is hereby created whose duty it shall be to administer the provisions of this Act. The Board shall consist of five professional engineers, who shall be appointed by the Governor from among nominees recommended by the representative engineering societies in the State and shall have the qualifications required by Section 4. The members of the first Board shall be appointed within ninety days after the passage of this Act, to serve for the following terms: One member for one year, one member for two years, one member for three years, one member for four years, and one member for five years, from the date of their appointment, or until their successors are duly appointed and qualified. Every member of the Board shall receive a certificate of his appointment from the Governor and before beginning his term of office shall file with the Secretary of State his written oath or affirmation for the faithful discharge of his official duty. Each member of the Board first appointed hereunder shall receive a certificate of registration under this Act from said Board. On the expiration of the term of any member, the Governor shall in the manner hereinbefore provided appoint for a term of five years a registered professional engineer, having the qualifications required by Section 4, to take the place of the member whose term on said Board is about to expire. Each member shall hold office until the expiration of the term for which such member is appointed or until a successor shall have been duly appointed and shall have qualified.

Section 4.—Qualifications of Members of Board.—Each member of the Board shall be a citizen of the United States and a resident of this State, and shall have been engaged in the practice of the profession of engineering for at least twelve years, and shall have been in responsible charge of important engineering work for at least five years. Responsible charge of engineering teaching may be construed as responsible charge of important engineering work.

Section 5.—Compensation and Expenses of Board Members.—Each member of the Board shall receive the sum of ..... dollars ($....) per diem when actually attending to the work of the Board or of any of its committees and for the time spent in necessary travel; and, in addition thereto, shall be reimbursed for all actual traveling, incidental, and clerical expenses necessarily incurred in carrying out the provisions of this Act.

Section 6.—Removal of Members of Board.—Vacancies.—The Governor may remove any member of the Board for misconduct, incompetency, neglect of duty, or for any other sufficient cause. Vacancies in the membership of the Board shall be filled for the unexpired term by appointment by the Governor as provided in Section 3.

Section 7.—Organization and Meetings of the Board.—The Board shall hold a meeting within thirty days after its members are first appointed, and thereafter shall hold at least two regular meetings each year. Special meetings shall be held at such time as the by-laws of the Board may provide. Notice of all meetings shall

be given in such manner as the by-laws may provide. The Board shall elect or appoint annually the following officers. A Chairman, a Vice-Chairman, and a Secretary. A quorum of the Board shall consist of not less than three members.

Section 8.—Powers of the Board.—The Board shall have the power to make all by-laws and rules, not inconsistent with the Constitution and Laws of this State, which may be reasonably necessary for the proper performance of its duties and the regulations of the proceedings before it. The Board shall adopt and have an official seal.

In carrying into effect the provisions of this Act, the Board may, under the hand of its Chairman and the seal of the Board, subpoena witnesses and compel their attendance, and also may require the production of books, papers, documents, etc., in a case involving the revocation of registration or practicing or offering to practice without registration. Any member of the Board may administer oaths or affirmations to witnesses appearing before the Board. If any person shall refuse to obey any subpoena so issued, or shall refuse to testify or produce any books, papers, or documents, the Board may present its petition to (such authority as may have jurisdiction), setting forth the facts, and thereupon such (authority) shall, in a proper case, issue its subpoena to such person, requiring his attendance before such (authority) and there to testify or to produce such books, papers, and documents, as may be deemed necessary and pertinent by the Board. Any person failing or refusing to obey the subpoena or order of the said (authority) may be proceeded against in the same manner as for refusal to obey any other subpoena or order of the (authority).

Section 9.—Receipts and Disbursements.—The Secretary of the Board shall receive and account for all moneys derived under the provisions of this Act, and shall pay the same monthly to the State Treasurer, who shall keep such moneys in a separate fund to be known as the "Professional Engineers' Fund." Such fund shall be kept separate and apart from all other moneys in the Treasury, and shall be paid out only by warrant of the State Auditor upon the State Treasurer, upon itemized vouchers, approved by the Chairman and attested by the Secretary of the Board. All moneys in the "Professional Engineers' Fund" are hereby specifically appropriated for the use of the Board. The Secretary of the Board shall give a surety bond to this State in such sum as the Board may determine. The premium on said bond shall be regarded as a proper and necessary expense of the Board, and shall be paid out of the "Professional Engineers' Fund." The Secretary of the Board shall receive such salary as the Board shall determine in addition to the compensation and expenses provided for in Section 5. The Board may employ such clerical or other assistants as are necessary for the proper performance of its work, and may make expenditures of this fund for any purpose which in the opinion of the Board is reasonably necessary for the proper performance of its duties under this Act, including the expenses of the Board's delegates to annual convention of, and membership dues to, the National Council of State Boards of Engineering Examiners. Under no circumstances shall the total amount of warrants issued by the State Auditor in payment of the expenses and compensation provided for in this Act exceed the amount of the examination and registration fees collected as herein provided.

Section 10.—Records and Reports.—The Board shall keep a record of its proceedings and a register of all applications for registration, which register shall show (*a*) the name, age, and residence of each applicant; (*b*) the date of the application; (*c*) the place of business of such applicant; (*d*) his educational and other qualifications; (*e*) whether or not an examination was required; (*f*) whether the applicant was rejected; (*g*) whether a certificate of registration was granted; (*h*) the date of the action of the Board; and (*i*) such other information as may be deemed necessary by the Board.

The records of the Board shall be *prima facie* evidence of the proceedings of the Board set forth therein, and a transcript thereof, duly certified by the Secretary of the Board under seal, shall be admissible in evidence with the same force and effect as if the original were produced.

Annually, as of ..... [insert date], the Board shall submit to the Governor a report of its transactions of the preceding year, and shall also transmit to him a complete statement of the receipts and expenditures of the Board, attested by affidavits of its Chairman and its Secretary.

Section 11.—Roster of Registered Engineers and Surveyors.—A roster showing the names and places of business of all registered professional engineers and all registered land surveyors shall be prepared by the Secretary of the Board during the month of ..... of each year, commencing one year from the date this law becomes effective. Copies of this roster shall be mailed to each person so registered, placed on file with the Secretary of State, and furnished to the public upon request.

Section 12.—General Requirements for Registration.—The following shall be considered as minimum evidence satisfactory to the Board that the applicant is qualified for registration as a professional engineer, or land surveyor, respectively, to wit:

(1) As a professional engineer:
   a.—Graduation from an approved course in engineering of four years or more in a school or college approved by the Board as of satisfactory standing; and a specific record of an additional four years or more of active practice in engineering work of a character satisfactory to the Board, and indicating that the applicant is competent to be placed in responsible charge of such work; or
   b.—Successfully passing a written, or written and oral, examination designed to show knowledge and skill approximating that attained through graduation from an approved four-year engineering course; and a specific record of eight years or more of active practice in engineering work of a character satisfactory to the Board and indicating that the applicant is competent to be placed in responsible charge of such work.

(2) As a land surveyor:
   a.—Graduation from an approved course in surveying in a school or college approved by the Board as of satisfactory standing; and an additional two years or more of active practice in land surveying work of a character satisfactory to the Board and indicating that the applicant is competent to be placed in responsible charge of such work; or
   b.—Successfully passing a written, or written and oral, examination in surveying prescribed by the Board; and a specific record of six years or more of active practice in land surveying work of a character satisfactory to the Board and indicating that the applicant is competent to be placed in responsible charge of such work.

At any time within five years after this Act becomes effective the Board may accept as evidence that the applicant is qualified for registration as a professional engineer a specific record of twelve years or more of lawful active practice in engineering work of a character satisfactory to the Board and indicating that the applicant is qualified to design or to supervise construction of engineering works and has had responsible charge of important engineering work for at least five years and provided applicant is not less than thirty-five years of age.

At any time within five years after this Act becomes effective the Board may accept as evidence that the applicant is qualified for registration as a land surveyor a specific record of ten years or more of lawful active practice in land surveying work of a character satisfactory to the Board and indicating that the applicant has had responsible charge of important land surveying work for at least five years and provided applicant is not less than thirty years of age.

After this Act shall have been in effect five years, the Board shall issue Certificates of Registration only to those applicants who meet the requirements of Section 12, 1(*a*) or (*b*), or 2(*a*) or (*b*), of Section 21.

Provided, that no person shall be eligible for registration as a professional engineer, or land surveyor, who is not of good character and reputation.

In considering the qualifications of applicants, responsible charge of engineering teaching may be construed as responsible charge of engineering work. The satisfactory completion of each year of an approved course in engineering in a school or college approved by the Board as of satisfactory standing, without graduation, shall be considered as equivalent to a year of active practice. Graduation in a course other than engineering from a college or university

of recognized standing shall be considered as equivalent to two years of active practice; provided, however, that no applicant shall receive credit for more than four years of active practice because of educational qualifications. The mere execution, as a contractor, of work designed by a professional engineer, or the supervision of the construction of such work as a foreman or superintendent shall not be deemed to be active practice in engineering work.

Any person having the necessary qualifications prescribed in this Act to entitle him to registration shall be eligible for such registration though he may not be practicing his profession at the time of making his application.

Section 13.—Applications and Registration Fees.—Applications for registration shall be on forms prescribed and furnished by the Board, shall contain statements made under oath, showing the applicant's education and detail summary of his technical work, and shall contain not less than five references, of whom three or more shall be engineers having personal knowledge of his engineering experience.

The registration fee for professional engineers shall be twenty-five dollars ($25.00), fifteen dollars ($15.00) of which shall accompany application, the remaining ten dollars ($10.00) to be paid upon issuance of certificate. When a Certificate of Qualification issued by the National Bureau of Engineering Registration is accepted as evidence of qualification, the total fee for registration as professional engineer shall be ten dollars ($10.00).

The registration fee for land surveyors shall be fifteen dollars ($15.00), which shall accompany application. Should the Board deny the issuance of a certificate of registration to any applicant the initial fee deposited shall be retained as an application fee.

Section 14.—Examinations.—When oral or written examinations are required, they shall be held at such time and place as the Board shall determine. The scope of the examinations and the methods of procedure shall be prescribed by the Board with special reference to the applicant's ability to design and supervise engineering works, which shall insure the safety of life, health, and property. Examinations shall be given for the purpose of determining the qualifications of applicants for registration separately in professional engineering and in land surveying. A candidate failing on examination may apply for re-examination at the expiration of six months and will be re-examined without payment of additional fee. Subsequent examination will be granted upon payment of a fee to be determined by the Board.

Section 15.—Certificates.—Seals.—The Board shall issue a certificate of registration upon payment of registration fee as provided for in this Act, to any applicant who, in the opinion of the Board, has satisfactorily met all the requirements of this Act. In case of a registered engineer, the certificate shall authorize the practice of "professional engineering," and in the case of a registered land surveyor, the certificate shall authorize the practice of "land surveying." Certificates of registration shall show the full name of the registrant, shall have a serial number, and shall be signed by the Chairman and the Secretary of the Board under seal of the Board.

The issuance of a certificate of registration by this Board shall be evidence that the person named therein is entitled to all the rights and privileges of a registered professional engineer, or of a registered land surveyor, while the said certificate remains unrevoked or unexpired.

Each registrant hereunder shall upon registration obtain a seal of the design authorized by the Board, bearing the registrant's name and the legend, "Registered Professional Engineer," or "Registered Land Surveyor." Plans, specifications, plats, and reports issued by a registrant shall be stamped with the said seal when filed with public authorities, during the life of the registrant's certificate, but it shall be unlawful for anyone to stamp or seal any documents with said seal after the certificate of the registrant named thereon has expired or has been revoked, unless said certificate shall have been renewed or re-issued.

Section 16.—Expirations and Renewals.—Certificates of registration shall expire on the last day of the month of..... following their issuance or renewal and shall become invalid on that date unless renewed. It shall be the duty of the Secretary of the Board to notify every person registered under this Act, of the date of the expiration of his certificate and the amount of the fee that shall be required for its renewal for one year; such notice shall be mailed at least one month in advance of the date of the expiration of said certificate. Renewal may be effected at any time during the month of.....by the payment of a fee of .... dollars ($.....). The failure on the part of any registrant to renew his certificate annually in the month of .....as required above shall not deprive such person of the right of renewal, but the fee to be paid for the renewal of a certificate after the month of.....shall be increased 10 per cent for each month or fraction of a month that payment of renewal is delayed; provided, however, that the maximum fee for delayed renewal shall not exceed twice the normal renewal fee.

Section 17.—Firms, Partnerships, Corporations, and Joint Stock Associations.—A firm, or a co-partnership, or a corporation, or a joint stock association may engage in the practice of professional engineering or land surveying in this State, provided only such practice is carried on by professional engineers or land surveyors, respectively, registered in this State.

Section 18.—Practitioners at Time Act Became Effective.—At any time within one year after this Act becomes effective, upon due application therefor and the payment of the registration fee of twenty-five dollars ($25.00) for professional engineers, or fifteen dollars ($15.00) for land surveyors, the Board shall issue a certificate of registration, without oral or written examination, to any professional engineer or land surveyor who shall submit evidence under oath satisfactory to the Board that he is of good character, has been a resident of the state of .....for at least one year immediately preceding the date of his application, and was practicing professional engineering if an engineer, or land surveying if a surveyor, at the time this Act became effective, and has had responsible charge of work of a character satisfactory to the Board.

After this Act shall have been in effect one year, the Board shall issue certificates of registration only as provided for in Section 12 or Section 21 thereof.

Section 19.—Public Work.—After the first day of....., one thousand nine hundred and....., it shall be unlawful for this State, or for any of its political sub-divisions, for any county, city, town, township, or borough to engage in the construction of any public work involving professional engineering, unless the plans and specifications and estimates have been prepared by, and the construction executed under the direct supervision of, a registered professional engineer; provided, that nothing in this Section shall be held to apply to any public work wherein the contemplated expenditure for the completed project does not exceed two thousand dollars ($2,000.00).

Section 20.—Exemptions.—The following persons shall be exempt from the provisions of this Act, to wit:

(*a*) A person not a resident of and having no established place of business in this State, practicing or offering to practice herein the profession of engineering or land surveying, when such practice does not exceed in the aggregate more than sixty days in any calendar year; provided, such person is legally qualified by registration to practice the said profession in his own State or Country in which the requirements and qualifications for obtaining a certificate of registration are not lower than those specified in this Act.

(*b*) A person not a resident of and having no established place of business in this State, or who has recently become a resident thereof, practicing or offering to practice herein for more than sixty days in any calendar year the profession of engineering or land surveying, if he shall have filed with the Board an application for a certificate of registration and shall have paid the fee required by this Act. Such exemption shall continue only for such time as the Board requires for the consideration of the application for registration; provided, that such a person is legally qualified to practice said profession in his own State or country in which the requirements and qualifications for obtaining a certificate of registration are not lower than those specified in this Act.

(*c*) An employee or a subordinate of a person holding a certificate of registration under this Act, or an employee of a person exempted from registration by Classes (*a*) and (*b*) of this Section; provided, his practice does not include responsible charge of design or supervision.

(*d*) Officers and employees of the Government of the United States while engaged within this State in the practice of the profession of engineering or land surveying, for said Government.

Section 21.—Reciprocity.—The Board may, upon application

therefor, and the payment of a fee of ten dollars ($10.00), issue a certificate of Registration as a Professional Engineer to any person who holds a Certificate of Qualification or Registration issued to him by proper authority of the National Council of State Boards of Engineering Examiners, or of the National Bureau of Engineering Registration, or of any State or Territory or Possession of the United States, or any Country, provided that the requirements for the registration of professional engineers under which said Certificate of Qualification or Registration was issued do not conflict with the Provisions of this Act and are of a standard not lower than that specified in Section 12 of this Act.

Section 22.—Revocations and Re-Issuances of Certificates.—The Board shall have the power to revoke the certificate of registration of any registrant who is found guilty of:

(*a*) The practice of any fraud or deceit in obtaining a certificate of registration;

(*b*) Any gross negligence, incompetency, or misconduct in the practice of professional engineering or land surveying as a registered professional engineer or land surveyor.

Any person may prefer charges of fraud, deceit, gross negligence, incompetency, or misconduct against any registrant. Such charges shall be in writing, and shall be sworn to by the person making them and shall be filed with the Secretary of the Board.

All charges, unless dismissed by the Board as unfounded or trivial, shall be heard by the Board within three months after the date on which they shall have been preferred.

The time and place for said hearing shall be fixed by the Board, and a copy of the charges, together with a notice of the time and place of hearing, shall be personally served on or mailed to the last known address of such registrant, at least thirty days before the date fixed for the hearing. At any hearing, the accused registrant shall have the right to appear personally and by counsel, to cross-examine witnesses appearing against him, and to produce evidence and witnesses in his own defense.

If, after such hearing, three or more members of the Board vote in favor of finding the accused guilty, the Board shall revoke the certificate of registration of such registered professional engineer or land surveyor.

The Board, for reasons it may deem sufficient, may re-issue a certificate of registration to any person whose certificate has been revoked, providing three or more members of the board vote in favor of such re-issuance. A new certificate of registration, to replace any certificate revoked, lost, destroyed, or mutilated, may be issued, subject to the rules of the Board, and a charge of three dollars ($3.00) shall be made for such issuance.

Section 23.—Violations and Penalties.—Any person who shall practice, or offer to practice, the profession of engineering or land surveying in this State without being registered or exempted in accordance with the provisions of this Act, or any person presenting or attempting to use as his own the certificate of registration or the seal of another, or any person who shall give any false or forged evidence of any kind to the Board or to any member thereof in obtaining a certificate of registration, or any person who shall falsely impersonate any other registrant of like or different name, or any person who shall attempt to use an expired or revoked certificate of registration, or any person who shall violate any of the provisions of this Act, shall be guilty of a misdemeanor, and shall, upon conviction, be sentenced to pay a fine of not less than one hundred dollars ($100.00), nor more than five hundred dollars ($500.00), or suffer imprisonment for a period not exceeding three months, or both.

It shall be the duty of all duly constituted officers of the law of this State, or any political subdivision thereof, to enforce the provisions of this Act and to prosecute any persons violating same. The Attorney General of the State or his assistant shall act as legal adviser of the Board and render such legal assistance as may be necessary in carrying out the provisions of this Act.

Section 24.—Saving Clause.—This Act shall not be construed to affect or prevent the practice of any other legally recognized profession.

Section 25.—Invalid Sections.—If any Section or Sections of this Act shall be declared unconstitutional or invalid, this shall not invalidate any other Sections of this Act.

Section 26.—Repeal of Conflicting Legislation.—All laws or parts of laws in conflict with the provisions of this Act shall be, and the same are hereby, repealed.

New Form for Applications List

ONE of the distinctive features that has characterized PROCEEDINGS for many years has been the inclusion of a section containing the records of applicants for membership in the Society or for promotion to a higher grade of membership. Prior to February 1923 this list was printed separately and sent to each Corporate Member. Still later, it was inserted in PROCEEDINGS as a matter of economy and printed as a separate paging of the volume between the first section of Society Affairs and the last section of Papers and Discussions. With the inauguration of CIVIL ENGINEERING came a further change in that the Items of Interest and Society Affairs were transferred to the latter publication and the Applications List was moved to the back of PROCEEDINGS.

Now still another adjustment of this essential element in the proper selection of members of the Society is to be made. The time-honored form, which has consisted of a rather complete résumé of the experience of the applicant, is to be abbreviated, giving the essential details in much more condensed form and thereby accommodating the full number of records in a much smaller space. Inasmuch as this particular part of PROCEEDINGS has been one of the most expensive in the volume, it is hoped to secure an appreciable saving by the new form and thereby to release space that may be properly used for the technical content.

Doubtless the main purpose of issuing the Applications List is in order that members may be informed of the names of applicants and thus given an opportunity to transmit their views, favorable or otherwise, to Headquarters. This main purpose is attained in the new form, and it is hoped that this list will continue to be a safeguard, ensuring that only qualified persons are elected to membership.

There are certain officers and groups that will need more complete information as to applicants. Among these are the members of the Board of Direction, the Corporate Members to whom the applicant refers, and the local membership committees. All these will be provided with the complete records, issued from Headquarters.

This change in the Applications List is to go into effect with the August issue, which will shortly be mailed to every member. Among the advantages of the change is that it makes PROCEEDINGS more completely what it is essentially designed to be—a technical publication presenting the most advanced thought of the civil engineering profession in America. Thus, not only is an economy effected but, from the publication standpoint, a forward step is taken.

Information Requested Regarding Uplift Pressure

AN OPEN LETTER

To Engineers in All Parts of the World:

THE COMMITTEE on Dams of the American Society of Civil Engineers is making a study of hydrostatic pressure both within and under the bases of dams. In this connection the committee invites the cooperation of engineers in every country who are designing or constructing dams.

The committee desires facts, as noted by careful observation, and not opinions or theoretical discussions. Present knowledge regarding actual uplift under and within dams is limited. Therefore we ask engineers, when designing a dam, to incorporate in their plans methods of observing the hydrostatic pressures which will develop when the structure goes into service. All useful information that comes to the committee will be incorporated in its reports for the benefit of the profession and full credit will be given to those who furnish reliable data.

Each engineer may design a method to measure uplift to suit his local conditions. The simplest installation for observing uplift is a system of pipes in which the pressure at the lower end may be measured by gage or in a riser pipe. All pipes should be built into the dam as it is being constructed, with their lower ends open. For measuring hydrostatic uplift under the base, the pipes should terminate in suitably arranged cavities, filled with granular material, at the base of the structure. The pipes should be spaced at intervals along the length of the dam, and at each location there should be not less than three pipes in an up- and downstream direction, this number increasing with the width of the base. If a rock foundation has extensive or nearly horizontal stratifications, other pipes should be carried down below the base to some of the

rock joints. The locations and elevations below the base should be governed by the character of the foundation material, whether rock or soil, and the purpose should be to locate the pipes systematically in both longitudinal and transverse directions with the view to developing all possible conditions.

For measuring hydrostatic uplift within the structure, similar pipes should be arranged with their open lower ends at different elevations above the base, as the design of the structure will permit. It would be well to have their lower ends open into horizontal construction joints.

The pipes may be led to one or more central observing points as found convenient, so long as the grade is always upward. The size of the pipes is not important, but should be such as to permit observations of the water levels within them.

The cost of installing such pipes will be small when a dam is under construction, while the benefits to be derived may be very great. The public has a direct interest in the safety of dams.

We urgently request that the following procedure be carried out:

1. Observe the water level or water pressure in each pipe at intervals, which should be practically simultaneous for each cross section, recording also the levels of the reservoir and tailwater surfaces. The observation intervals should be frequent as the reservoir is filling. Thereafter every week or every month will suffice. At least a year's observations should be recorded.

2. Observe the temperature of the water, both in the reservoir and in the pipes. There is some evidence that uplift pressure may be affected by temperature.

3. Send us the observations at intervals, also drawings of the dam showing the pipe locations and necessary cross sections, all to scale. The drawings should illustrate the details of the cut-off and the drainage system, if any, and show all other pertinent data. Also describe the character of concrete or masonry, and methods employed to secure bonding and to obstruct flow of water through the structure.

4. Send a detailed description of the foundation material, presenting all of its known characteristics, together with geological sections, both longitudinal and transverse, showing joint systems, faults, bedding, etc. Photographs of the foundations also will be useful.

5. Repeat the observations asked for in Paragraphs 1 and 2 sufficiently often so that seasonal variations will be disclosed. These repeated observations should be sent when made. Do not hold back the data asked for in 1, 2, 3, and 4, as its receipt may suggest the securing of other information that may be highly important.

6. Send all communications to H. de B. Parsons, M. Am. Soc. C.E., 26 Beaver Street, New York, U. S. A., who will acknowledge for the committee.

The committee would be glad to correspond regarding details, should anyone so desire.

COMMITTEE ON DAMS

Thaddeus Merriman, *Chairman*
Frederick H. Fowler
D. C. Henny
J. B. Lippincott
H. de B. Parsons
Charles B. Wing
Silas H. Woodard

July 19, 1932

Two Freeman Scholarships Awarded

FOR THE year 1932–1933 it has been decided to bestow two Freeman Traveling Scholarships for research work and study in Europe. This action was recommended by the Society's committee in charge of the scholarship and was accepted and adopted by the Board of Direction at its meeting on July 4 and 5. This unusual opportunity will therefore be open to Herbert H. Wheaton, Assoc. M. Am. Soc. C.E., of Berkeley, Calif., and Donald P. Barnes, Jun. Am. Soc. C.E., of Rolla, Mo.

Most of Mr. Wheaton's professional experience has been in connection with hydraulics. His early school training was in Wisconsin. After a period in the Army, he studied at the University of Wisconsin, where he received his bachelor's degree. He has taught there and in Fresno State College, and has done extensive graduate work at the University of California in Berkeley. He has done considerable work on hydraulic models, has studied groundwater and allied problems. In Europe he hopes to devote his time especially to problems of hydraulic structures and the transportation of sediment in rivers.

Geographically Mr. Barnes' experience has been somewhat the opposite of Mr. Wheaton's. Although born in the East he was trained in the far West and afterward took up teaching in the Mississippi Valley. His later schooling and undergraduate work was done in Oregon, and his graduate work at the California Institute of Technology. After a year of work in southern California, he has spent the past year as instructor at the Missouri School of Mines. In addition to his interest in hydraulics he has shown proficiency in structural engineering, including studies of earthquake effects.

It is expected that these two new appointees will fully uphold the high standards set by Freeman Fund Scholars in Europe during the past few years. Mr. Wheaton expects to leave America to take up his studies abroad early in August, but Mr. Barnes will not go until a month or more later.

Formation of Indiana Local Section Approved

AT ITS meeting on July 4 the Board of Direction approved the formation of the Indiana Section of the Society, in line with similar action taken previously by the Executive Committee. Accordingly, the Indiana Section joins the others already established and becomes the newest group to carry on work through the medium of the Society organization.

Although the new Section is the only one in its state, it is flanked by Local Sections at Toledo, Columbus, Dayton, and Cincinnati, Ohio, on the east; and by the Central Illinois and the Illinois (Chicago) Sections on the west. Officers of the new Section will include Prof. S. C. Hollister, president; H. S. Morse, vice-president; and Prof. W. A. Knapp, secretary-treasurer, Purdue University, Lafayette, Ind.

Two New Student Chapters

AFTER application in prescribed form had been made and the regulation covering the organization of Student Chapters complied with, the Board of Direction at its meeting on July 4 and 5 approved the establishment of Chapters at Louisiana State University, Baton Rouge, La., and at Rhode Island State College, Kingston, R.I. Both these new organizations add measurably to the effectiveness of Society work; both are the only Student Chapters within their respective states.

At present the Louisiana State Chapter has the field largely to itself, its nearest neighbors on the west being at the Rice Institute, Houston, Tex.; on the north, at the Mississippi Agricultural and Mechanical College and the University of Mississippi; and, on the east, at the University of Alabama and the Alabama Polytechnic Institute.

The Rhode Island State College Chapter will be fairly near five Student Chapters, those at the Worcester Polytechnic Institute, Tufts College, Harvard University, and the Massachusetts Institute of Technology on the north, and that at Yale University about the same distance to the west.

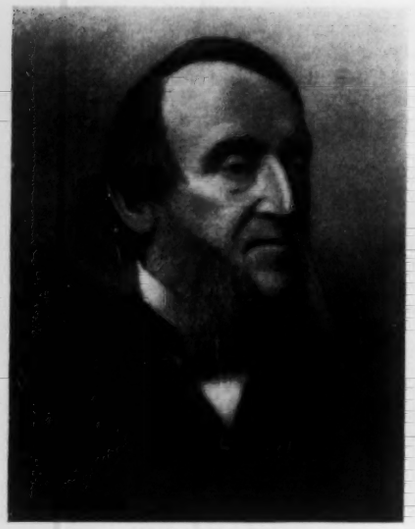
The faculty sponsors are Prof. F. F. Pillet, at Louisana State University, and Prof. Carroll D. Billmyer, at the Rhode Island State College. It is expected that active work in these two new organizations will start with the opening of college in the fall.

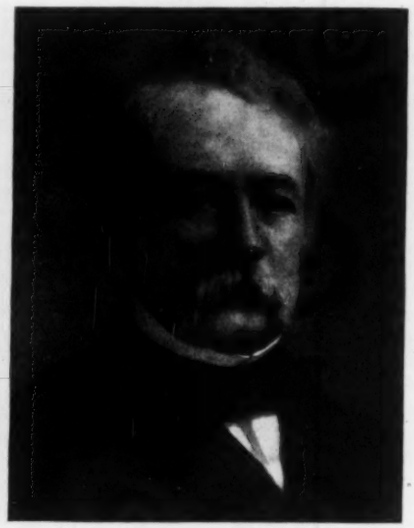
Engineers Need Clothing

THE PROFESSIONAL Engineers' Committee on Unemployment (P.E.C.U.), representing the Four Founder Societies in Metropolitan New York, reports that its supply of used clothing is seriously depleted. The committee has sent out a plea for contributions of clothing to distribute to needy and deserving engineers and their families. Not only is men's clothing needed; women's and children's wear will also be gladly accepted. Parcels should be sent to the Professional Engineers' Committee on Unemployment, at the McGraw-Hill Building, 330 West 42d Street, New York, N.Y.

Transactions for 1932 in Preparation

NEAR the beginning of the first volume of TRANSACTIONS, published in 1872, will be found the annual address of the third president of the Society, William Jarvis McAlpine, who held that office in 1868–1869. A pertinent thought is quoted from his speech of sixty-odd years ago:





WILLIAM JARVIS MCALPINE ALFRED WINGATE CRAVEN

Third and Fourth Presidents of the American Society of Civil Engineers

"Our Society has been established for the purpose of advancing knowledge, science, and practical skill among its members by an interchange of thoughts, studies, and experiences."

In 1888, Past-President McAlpine was elected to Honorary Membership in the Society. He died on February 16, 1890, at the age of 77, after a long career in the profession.

PRESIDENTIAL ADDRESS

Thumbing through this first volume of TRANSACTIONS, further along, a reader will come upon the presidential address of Alfred Wingate Craven, fourth President of the Society (1869–1871), in whose office, on November 5, 1852, twelve men met to organize the Society. Mr. Craven was for many years Chief Engineer and Commissioner of the Croton Aqueduct Department of the City of New York. He said in 1870:

"Original papers form the main, if not the only, reliable food for the permanent health of our Society. They are the substance. The discussions which follow are the gastric juice which helps that substance to assimmilate with the system and nourish the body."

The foregoing quotations from this early volume indicate the clear vision of our founders in insisting upon the value of a constant interchange and recording of technical experiences among our members. It is interesting in the light of this retrospection to call attention to Volume 96 of TRANSACTIONS. This book, which is now in process of preparation, will contain about 1,800 pages of interest to engineers in all the specialized branches of civil engineering. Twenty-four authors are represented and their papers cover a range of at least fifteen major topics, as for example, the theory of structures, hydrology, construction, weirs, hydraulics, dams, mathematics, rainfall, hydraulic dredges, highways, surveying, canals, city planning, tunnels, irrigation, and concrete.

At a meeting of the Society on December 4, 1867, James P. Kirkwood, second President of the Society, delivered a formal address, which also was printed in the first volume of the TRANSACTIONS of the Society. Mr. Kirkwood deals specifically with the problems confronting the Society as an organization at that early date, drawing from his experiences of the few years preceding. In regular course other Presidents of the Society have similarly outlined for its members and the profession at large the most serious problems and conditions existing at the particular time. Consequently these addresses form the guide posts along the highway that the Society has traveled during the intervening years.

In Volume 96 of TRANSACTIONS will appear the annual address of Herbert S. Crocker, sixty-third President of the Society. This was read at the sixty-second Annual Convention of the Society, held at Yellowstone National Park on July 6–9. In a period of tremendous consequence to the future of civil engineers, Colonel Crocker has chosen a subject of timely interest. This has been propounded in two basic questions: first, the relationship between engineer and contractor on construction work; and second, the future of the civil engineer as affected by changing economic trends.

CURRENT MEMOIRS OF DECEASED MEMBERS

The volume will also include the memoirs of deceased members that have been compiled during the current year. These have not previously been published in PROCEEDINGS, having appeared from time to time only in the form of reprints distributed in limited numbers to friends and relatives. Volume 96 of TRANSACTIONS will be sent out to members in the early autumn. It may be secured in a cloth binding for $1.00 extra, and in half-morocco for $2.00 extra.

A Valuable File

WHEN the new supply of forms for the Society's Permanent Biographical and Professional Records was mailed in December 1931 to the entire membership, there had already been received and filed similar information from 6,870 present or former members. Immediately after these blanks were sent out the records were returned in large numbers, both from those men who had previously filed this information, and from those who had hitherto neglected to do so. A count made as of June 1, 1932, shows that at that date there were on file a total of 8,077 records, not counting duplicates and supplementary forms. Of these, 1,207 were from men not previously represented in this file. No count was made of the blanks submitting material which supplemented records already on file, which blanks were attached to these records to bring them up to date.

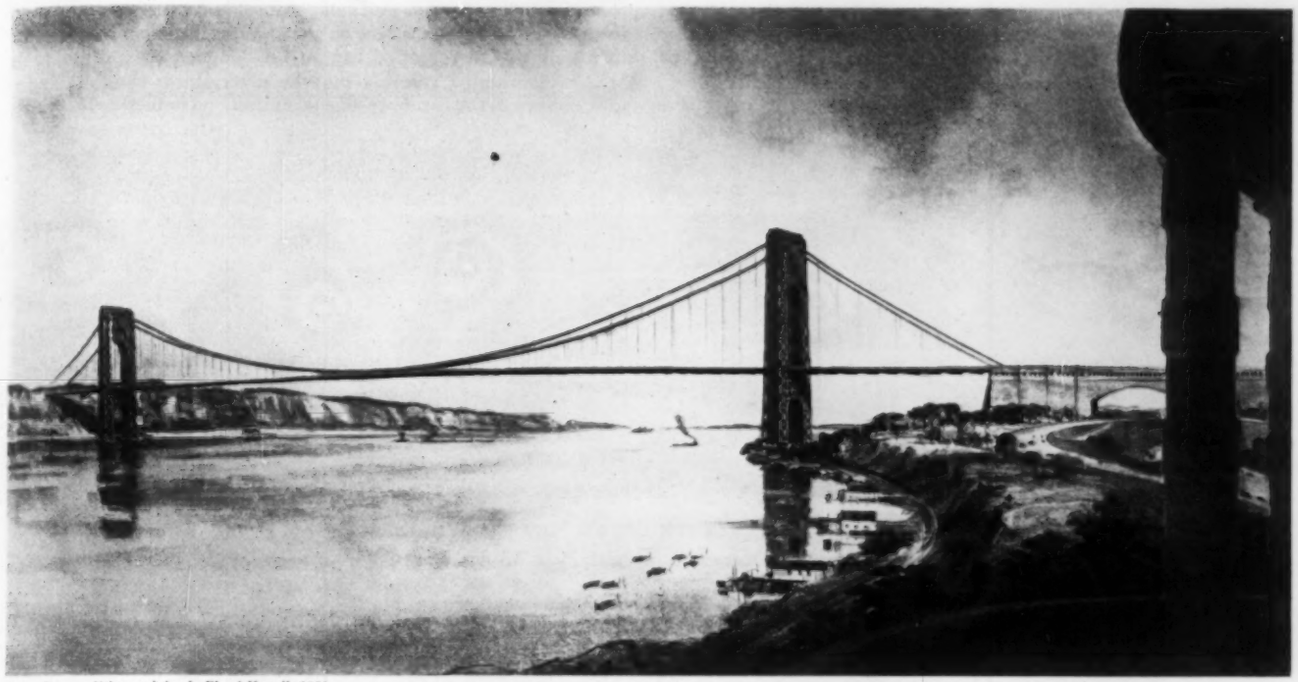
It will be remembered that the file of professional records was started in December 1921. All material has been preserved, but a distinction is made to show which men are still members. Of the present grand total of 8,077 names, 354 men have died since their records were sent in, and 690 have otherwise ceased to be members

Subtracting the numbers in these two groups from the total leaves 7,033 men now on the membership books of the Society represented in this list. As the total membership on May 31 was 15,356, it is evident that only about 46 per cent of the members have responded to the request to furnish this information.

Among other classifications made from this file, there is a subject index showing the names of the men equipped for specialized engineering fields. This index is kept up to date by continuous additions made from the records as received. It is frequently called upon to aid in finding an engineer to fill a position, especially if it happens to be one that is out of the ordinary.

In response to a recent inquiry of the Employment Service, the records of several possible candidates were produced. The first thing the inquirer did was to scrutinize the records to discover whether these men could speak the German language. Two of the men under consideration had degrees from German universities, a fact that made the choice so much the simpler.

It is hoped that those who have not brought up to date their records in the Society's files will take advantage of this reminder to supply the missing data. A card addressed to Headquarters will secure the necessary forms.



From a lithograph by J. Floyd Yewell, 1931

THE GEORGE WASHINGTON BRIDGE AT 179TH STREET, NEW YORK

Plans Provide for Facing the Towers with Granite and for the Addition of a Rapid Transit Deck Below the Roadway When Needed

A Preview of Proceedings

Resumption of the publication of PROCEEDINGS *after the summer interval will be marked by the inclusion, in the August issue, of the first of a symposium of papers completely describing all the engineering phases of the George Washington Bridge across the Hudson River at New York, opened for traffic in October 1931. The first part of the symposium deals with the initial considerations and the general conception of this remarkable structure.*

Also in this issue will be included a paper recently read before the 1932 Annual Convention in Yellowstone National Park, dealing with the actual effect of deforestation on the run-off from mountainous areas in the West. By a fortunate circumstance this valuable paper had already been scheduled for official publication when it was chosen for the Convention program. Thus it will become immediately available in printed form for the benefit of the entire membership.

THE GEORGE WASHINGTON BRIDGE—A SYMPOSIUM

By a cooperative agreement with the Port of New York Authority, the Society is enabled to announce that the complete account of the technical findings made and experience acquired during the building of the George Washington Bridge will be made available to the membership for open discussion and for ultimate professional record in the archives of the Society. From time to time, as the publication program of PROCEEDINGS permits, it is planned to present other articles of the symposium. Each part will be written separately by an engineer in direct contact with the work.

Fittingly, the first paper of this series, which appears in PROCEEDINGS for August, is by O. H. Ammann, M. Am. Soc. C.E., the Chief Engineer of the Port of New York Authority. It is fortunate, also, that his paper surveys the work as a whole, and has chapters on history (including the proposed 57th Street Bridge), traffic, economic specifications, topographical conditions, surveys and borings, geological conditions, types of bridges, studies of floor construction, stiffening process and wind bracing, cables and anchorages, towers, approaches, and highway connections.

His treatise on the types of bridges considered for the Hudson River crossing, his discussion of the relative merits of cantilever and long-span suspension bridges for such a crossing, and his advocacy of the relatively light stiffening truss system marks this as an epoch-making paper. It constitutes a clear statement of the most modern phase of the bridge builder's art, as established, classified, and interpreted by the great bridge engineers of the past.

FOREST AND STREAM FLOW

For many years there has been wide discussion among engineers, foresters, nature lovers, and water users in general, as to the effect of forests on stream flow. The public has usually accepted the popular doctrine that the effect is very beneficial. Most hydraulic engineers, on the other hand, have been of the opinion that there is not sufficient evidence to warrant a definite statement in favor of either position. The authors of this paper, W. G. Hoyt, M. Am. Soc. C.E., and H. C. Troxell, Assoc. M. Am. Soc. C.E., present the results of studies conducted by Government and state agencies, to determine the effect of forests in two localities.

The first locality, in Colorado, was studied during the period from 1910 to 1926, when the U.S. Forest Service and the U.S. Weather Bureau conducted a joint investigation for the express purpose of obtaining, if possible, conclusive evidence as to the actual effect of deforestation on stream flow. Two small, contiguous, timbered mountain tracts near Wagonwheel Gap in that state were selected for study because they were subject to practically identical meteorologic conditions. Detailed observations of run-off, rainfall, snowfall, and ground and air temperatures were made for each tract over a period of eight years. The timber was then removed from one of the tracts and the observations continued for seven years more.

In cooperation with the State Engineer of California and the County of Los Angeles, the U.S. Geological Survey initiated a study of the second locality in 1916 and 1917 by establishing gaging stations on Fish Creek and Santa Anita Creek, tributary to the San Gabriel River, in southern California. This was part of the nation-wide investigation of stream flow begun as early as 1890. In September 1924, a forest fire burned all the Fish Creek area above the gaging station but the fire was brought under control before it reached the Santa Anita basin. The gaging stations have been continued on both streams to date. Through accident, therefore, an opportunity was afforded to make a study fairly comparable to the investigation near Wagonwheel Gap.

Details of the studies of Wagonwheel Gap are published in a Government report, "Forest and Stream-Flow Experiment at

Wagonwheel Gap, Colorado," by C. G. Bates and A. J. Henry; *Monthly Weather Review*, Supplement 30, copies of which may be obtained from the U.S. Forest Service, Washington, D.C. The studies in southern California have never been published.

It appears, therefore, that now for the first time definite facts based on comprehensive and comparable observations are available from which the actual effect on the stream flow from a deforested mountain in Colorado and from a fire-denuded coastal mountain area in southern California may be determined, thus making it unnecessary in the future to depend entirely on inductive reasoning.

PROPOSED SUSPENSION BRIDGE OVER THE HUDSON RIVER AT 57TH STREET, NEW YORK
As Designed by Gustav Lindenthal, Hon. M. Am. Soc. C.E.

American Engineering Council

National representative of 26 engineering societies, with a constituent membership of 60,000 professional engineers, reports civil engineering news of the Federal Government

Federal Government Economy Law Enacted

On June 30, President Hoover signed H.R. 11267, making it Public Law 212 of the 72d Congress. This law was in reality the appropriation bill for the legislative branch of the Federal Government but attached to it as a rider was Part II, the so-called Omnibus Economy Bill.

Provision was made for the furlough of Federal Government employees receiving more than $1,000 per annum for not to exceed 30 days per year without pay. Of necessity, numerous exceptions and exemptions are contained in the bill, due to definitions, arrangements for compensation reductions, retired pay, special salary reductions, and remittances from constitutional officers.

Title II of the law provides for the suspension of promotions and the filling of vacancies, for compulsory retirement for age, and for temporary and permanent reduction of travel allowances; prohibits overtime compensation; places limitations on the amount of retired pay; and requires in the event of the necessity for reduction of personnel in any branch or service of the Government that married persons (living with husband or wife) shall be dismissed before any other persons employed in such class are dismissed, if such husband or wife is also in the service of the United States or the District of Columbia. It also reduces the amount of annual leave with pay to 15 days and gives the heads of executive departments authority to furlough employees during the fiscal year 1933 in the event that is necessary to keep within the appropriations.

MISCELLANEOUS PROVISIONS

Title III in part provides for the reorganization of the U.S. Shipping Board, and increases in fees and charges for services made by various departments. Restriction is placed on the transfer of Army and Navy personnel.

With the approval of the President, transfer of up to 12 per cent of any appropriation for an executive department or independent establishment may be made to any other appropriation or appropriations under the same department or establishment, with the limitation that no appropriation shall be increased more than 15 per cent by such transfers.

REORGANIZATION OF EXECUTIVE DEPARTMENTS

Title IV gives the President authority to group, coordinate, and consolidate executive and administrative agencies of the Federal Government according to their major purpose. Whenever the President makes an executive order, under the provisions of this Title, he must transmit the order to Congress and the order shall not become effective until after the expiration of 60 calendar days unless Congress shall sooner approve it. This section is of special interest to the engineering profession because it is felt that under it there may be effected a consolidation of the public works and construction activities of the Government.

Title V provides for the consolidation of the Steamboat Inspection Service and Bureau of Navigation of the Department of Commerce; the transfer of the Personnel Classification Board to the Civil Service Commission; the abolition of the International Water Commission; and the transfer of the Radio Division of the Department of Commerce to the Federal Radio Commission.

Title VI permits the purchase of supplies and material by one department from another and the interchange of their services.

PROVISIONS APPLICABLE TO VETERANS

Title VII creates a joint congressional committee to make a thorough investigation of the operation of the laws and regulations relating to the relief of veterans of all wars and persons receiving benefits on account of service of such veterans and to report a national policy with respect to such veterans and their dependents. This Title requires that the committee shall report to the House and Senate not later than January 1, 1933.

Title VIII contains special provisions, such as the separability clause, providing that, in the event any portion of this act is declared unconstitutional, the rest shall remain valid. It also provides for the suspension and repeal of all acts or parts of acts inconsistent or in conflict with the provisions of the Omnibus Economy Law. In addition, it makes the law applicable to appropriations available for the fiscal year 1933.

Appointments of Society Representatives

GEORGE W. FULLER and W. S. LEE, Members Am. Soc. C.E., and CHARLES F. LOWETH, Past-President Am. Soc. C.E., were appointed Society representatives on a committee suggested by United Engineering Trustees, Inc., to study the better definition and coordination of joint organizations of engineering societies.

CLYDE T. MORRIS, M. Am. Soc. C.E., represented the Society at the dedication exercises of the Daniel Guggenheim Airship Institute, at Akron, Ohio, June 26–27, in accordance with invitations received from the governing boards and faculties of the University of Akron and the California Institute of Technology.

ARTHUR S. TUTTLE, M. Am. Soc. C.E., represented the Society at the inauguration of William A. Boylan as President of Brooklyn College, Brooklyn, N.Y., June 21.

News of Local Sections

CENTRAL OHIO SECTION

The last session held by this Section before its adjournment for July and August, met on June 16 in Columbus and was devoted to business procedure Reports were presented on the activities of the Ohio State University Student Chapter, and on the financial condition of the Section. There were 16 members and guests present.

CLEVELAND SECTION

At the luncheon meeting held on June 7 at the Builders Exchange Building, 32 members and guests were in attendance. Business routine occupied a large part of the session. A report was given by Mr. Heffelfinger for his Committee on Unemployment, and Mr. Gascoigne reported for his Committee on Nominees for offices in the Society. Meetings are suspended for the summer, the next one to be held in October.

COLORADO SECTION

Election of officers for this Section was held on June 18, and resulted as follows: L. F. Copeland, President; E. L. Mosley, Vice-President; and R. J. Tipton, Secretary-Treasurer.

DULUTH SECTION

The following officers were elected for the Duluth Section for 1932: Earl Kelly, President; Leland Clapper, First Vice-President; A. C. Giesecke, Second Vice-President; William E. Hawley, Secretary; and John Carson, Treasurer.

ILLINOIS SECTION

At the luncheon meeting held by this Section in Chicago on May 27, the following guest speakers were heard: Professors Enger, Huntington, and Dolan, of the University of Illinois; Professors Rogers and Bennett, of Lewis Institute; Professors Wells and Jacobson, of Armour Institute of Technology; and Professor Hathaway, of Northwestern University.

NORTHWESTERN SECTION

On May 27, the Northwestern Section, with the University of Minnesota Student Chapter, held a well attended joint meeting at the Riverside Plant of the Northern States Power Company in Minneapolis. The meeting was addressed by James A. Colvin, on the subject of the "Development of Steam Power," in which he stressed the progress of recent years in the size and efficiency of units.

PHILADELPHIA SECTION

The annual meeting of the Philadelphia Section, held on June 14, was preceded by an afternoon of golf. The meeting was held at the Pennsylvania Golf Club in Frazer, and a large number of members and guests attended. George T. Seabury, Secretary of the Society, was the Section's guest and addressed the meeting on the Society's work for "A Normal Program of Public Works Construction," on Society financial matters, and other topics of interest. Officers for the coming year were elected as follows: C. E. Myers, President; Sanford W. Sawin and Charles S. Shaughnessy, Vice-Presidents; and Charles A. Howland, Secretary-Treasurer.

PITTSBURGH SECTION

Officers for the Pittsburgh Section have been elected as follows: P. J. Reich, President; and E. N. Hunting, Vice-President.

PORTLAND (OREGON) SECTION

Members of the Portland Section were guests at a meeting of the Professional Engineers of Oregon, held on April 20. The speaker of the evening was Maj. Oscar O. Kuentz, District Engineer of the Corps of Engineers, U.S. Army, Portland, Ore., who delivered an illustrated talk on "Navigation, Power, Irrigation, and Flood Control on the Columbia River." This subject was a very timely one and exceedingly interesting to all the members present. A meeting was held with the Student Chapter of Oregon State College at Corvallis, on Saturday, May 21. Members of the Section were shown the engineering laboratories and activities of the students in engineering. During and after the dinner which followed, there was musical entertainment, and after this a business meeting was held.

SEATTLE SECTION

The June meeting of the Seattle Section was held on the 20th. After a dinner, at which there were 26 in attendance, Dr. E. V. Lynn, of the University of Washington, gave a very interesting illustrated lecture on Yellowstone Park. Business routine occupied the remainder of the meeting.

ST. LOUIS SECTION

There were 32 members present at the regular meeting of this Section held on May 23. Various business details were attended to, after which Victor C. Houser, a four-minute speaker, representing the St. Louis campaign of "War Against Depression," outlined a program and requested the cooperation of the members of the Section.

SYRACUSE SECTION

Election of officers, held at the May 26 dinner meeting of this Section, resulted as follows: F. W. Stephens, President; F. B. Crocker, First Vice-President; E. F. Berry, Second Vice-President; and G. A. Helmstetter, Director.

Student Chapter News

CLARKSON COLLEGE OF TECHNOLOGY

The Clarkson Student Chapter reports that meetings have been held monthly throughout the year. At the March meeting, Capt. H. Brown, of the British Intelligence Service, spoke on "India," and in May the meeting was addressed by John R. Cheguidden, city manager and engineer of Massero, N.Y., on "Problems Confronting a City Engineer."

GEORGE WASHINGTON UNIVERSITY

Among the engineers who addressed meetings held by this Chapter during the past year were: W. N. Brown, of W. N. Brown, Inc., who spoke on "Aerial Photography and Mapping"; Luke A. Cole, Chief of Section of Datum Planes of the Tidal Division of the U.S. Coast and Geodetic Survey, who chose as his subject "Tidal Datum Planes and Their Uses to the Engineer"; and Riley E. Elgen, consulting engineer, who spoke on "Modern Transportation Systems." An inspection trip was taken on May 27 to the Baltimore Sewage Treatment Plant.

MARQUETTE UNIVERSITY

A very successful year has been enjoyed by the Marquette University Student Chapter. A joint meeting and dinner were held on November 19 with the Milwaukee Section. At this time Professor Riordon, of the Marquette College of Business Administration, told of his experiences during the Japanese earthquake of 1923. The December meeting was a joint session of the Chapter, the American Society of Mechanical Engineers, the American Institute of Electrical Engineers, and the American Society of Chemical Engineers. The program at this meeting consisted of sound films loaned and shown by the Western Electric Company, and "chemical antics" were presented by the newly formed Chemical Society. In February, at the annual chicken dinner, Mr. Ferebee, Commissioner of the Metropolitan Sewerage Commission, talked on "Licensing Engineers in Wisconsin"; and Mr. Howard, head of the Regional Planning Commission, spoke on "Regional Planning."

OHIO NORTHERN UNIVERSITY

Among the subjects discussed at meetings held by this Chapter during the past year were: "Topographical Surveying," and the "Scherzer Lift Bridge." The membership of the Chapter is 45.

STATE COLLEGE OF WASHINGTON

A number of the professors in the college addressed meetings of the Chapter. Among the subjects discussed were: "Shipping Canals," the "Conowingo Hydro-Electric Development," the "Florianopolis Bridge," "Mississippi Flood Control," and "Niagara Falls Power Development." The Chapter has a total of 22 members.

STATE UNIVERSITY OF IOWA

Among the subjects discussed at the meetings held by this Chapter during the past year were: "River Surveys," "Engineering Registration Laws in California," and the "Flow of Water on Curves." These meetings were well attended.

SYRACUSE UNIVERSITY

After the summer vacation, meetings of the Syracuse University Student Chapter were resumed on October 25. On November 12, a film was shown entitled "Recent Developments at Niagara Falls." On December 17 and March 3, films were shown on "Flood Control in Miami District," and "America's Great Bridge Test." Lectures were given by William C. Parkins, Chief Engineer of the National Paving Brick Association; A. E. Crockett, engineer with the Jones and Laughlin Steel Company of Buffalo; and Mr. Marble, Structural Engineer of the Carnegie Steel Company.

TUFTS COLLEGE

Engineers and members of the faculty of Tufts College addressed the members of this Chapter, at their meetings held during the past year, on a wide range of engineering subjects. At one of these meetings, Mr. Crandall, of the Crandall Engineering Company, related his experiences while constructing two drydocks of concrete in Ostend, Belgium. His talk was illustrated with slides.

UNION COLLEGE

Members of the Union College Student Chapter have enjoyed a number of gatherings throughout the past year. Most interesting and informative addresses were given by well-known engineers, among whom were: Robert Ridgway, Chief Engineer of the Board of Transportation of New York City; Albert A. Northrop of the Stone and Webster Engineering Corporation; K. W. Jappe, president of the Brookmire Economic Service; D. B. Steinman, consulting engineer; Francis Keally, architect; and David C. Coyle, consulting engineer.

UNIVERSITY OF AKRON

On March 8, this Chapter heard an address on "The Development, Manufacture, and Testing of Culverts," given by Mr. Gardner, representative of the Armco Culvert Manufacturing Association. The annual banquet was held on March 17, at which the principal speakers were: Dean Ayer of the college of engineering; E. D. Barstow, contact member; R. C. Durst, faculty sponsor; and J. Bulger, member of the faculty.

UNIVERSITY OF ARIZONA

Monthly meetings have been held by the University of Arizona Student Chapter during the past year. These were very interesting and consisted of talks and illustrated lectures given almost exclusively by the students.

UNIVERSITY OF COLORADO

Bi-monthly meetings were held by the University of Colorado Student Chapter. Upon these occasions papers were read by members of the senior class. Films were sometimes shown; and several addresses were given by visitors. Among these were: R. J. Tipton, special engineer in the State Engineers Office of Colorado; John E. Field, consulting engineer from Denver; and Mr. Funk, an employee of the Kansas City Structural Steel Company.

UNIVERSITY OF DAYTON

This Chapter's activities for the past year consisted of 12 meetings, two of which were held with the Local Section in the form of luncheon-lecture meetings. An inspection trip was taken to a concrete bridge failure near the city, and several trips were taken to watch the construction of the elevated railroad project in the city.

UNIVERSITY OF FLORIDA

The annual report of the University of Florida Student Chapter indicates that a noteworthy series of meetings have been held. A number of these meetings were addressed by student members on a wide range of engineering subjects. At the October 19 meeting, a talk was given by Prof. C. C. Brown, of the Civil Engineering Department, University of Florida; and at the April 18 meeting, H. C. Weathers, Division Engineer of Tests, Florida State Highway Department, spoke on "Mixed-in-Place Sand Asphalt Roads." A luncheon honoring Herbert S. Crocker, President of the Society, and George T. Seabury, Secretary, was held on January 18.

UNIVERSITY OF IDAHO

There were eight meetings held by the Chapter during the past year. On November 12, Prof. John W. Howard, of the College of Engineering, gave a talk on "High Lights in Engineering Education"; and a meeting held on May 3 was addressed by Colonel Gregory, of the Armco Pipe and Culvert Company, who gave an instructive talk on the design and placing of a culvert pipe.

UNIVERSITY OF KANSAS

A successful year has been enjoyed by the University of Kansas Student Chapter. Among the subjects discussed at their meetings were: "The Conowingo Hydro-Electric Development," "The New Santa Fe Bridge Across the Illinois River," and "The Florianopolis Bridge in Brazil." On April 17, an illustrated lecture on "The Hetch Hetchy Power Project" was presented.

UNIVERSITY OF KENTUCKY

Members of the University of Kentucky Student Chapter have enjoyed a number of meetings during the year. Among the interesting lectures heard at these meetings were the following: "The Archeology of Kentucky," "The Construction and Difficulties Encountered in Building the Holland Tunnel," "Underground Surveying," "National Defense," and "The Construction of Water Supply in Greece."

UNIVERSITY OF MAINE

There were seven regular meetings comprising the past year's activities in the University of Maine Student Chapter. The first of these meetings was addressed by B. L. Hopkins, State Hydraulic Engineer; and speakers at the subsequent meetings were: J. S. Brooks, Assistant Engineer with the Maine State Highway Commission; Henry Doten, construction engineer of that commission; E. H. Perkins, Professor of Geology at Colby College; and Donald M. Allen, sanitary engineer of Bucksport, Me.

UNIVERSITY OF MICHIGAN

The University of Michigan Student Chapter has had an active year. Business meetings were held every week or so and dinner meetings four or five times during the year, with an outside speaker or a lecture by a member of the faculty not on the engineering staff. Special meetings included the showing of the moving picture, "Empires of Steel," a film dealing with the construction of the Empire State Building.

UNIVERSITY OF MINNESOTA

Included on the list of lectures given at meetings held by the Chapter during the past year were the following: "Completion of the Through Train to California," "Snow Removal in Minnesota," "Waterways vs. Railroads," and "Elasticity of Materials." At the last meeting of the year, movies of the construction of the George Washington Bridge were shown.

UNIVERSITY OF MISSOURI

In the annual report of the University of Missouri Student Chapter a number of interesting meetings are listed. Among these was that held on December 1, when lantern slides on "The Mississippi Flood Control" were shown and several interesting talks were given. At the meeting held on April 5, the whole civil engineering school took a field trip to Bagnell Dam. This proved to be most educational and provided much valuable material.

UNIVERSITY OF NEBRASKA

There were 11 meetings held by the University of Nebraska Student Chapter during the school year. At the meeting held on December 2, the slide rule award, which is given each year to the civil engineering sophomore who makes the highest average as a freshman, was presented to Victor Chab.

UNIVERSITY OF NEVADA

Among the speakers heard by the Chapter during the past year were: Mr. Crowley, civil engineer in the employ of the Southern Pacific Railroad Company; Mr. Sager, meteorologist; H. M.

Engles, Chief Building Examiner for the Board of Underwriters of San Francisco; and S. C. Durkee, state highway engineer. At a joint meeting with the American Society of Mining Engineers, talks were given by J. B. Hefner and E. K. Pembaker, general manager and geologist, respectively, for the Consolidated Copper Mines Cooperation.

University of New Hampshire

During the past year the University of New Hampshire Student Chapter has held a number of very interesting and instructive meetings. On November 13, a lecture illustrated by slides and moving pictures was presented by Mr. Griffin, a representative of the National Paving Brick Association. His subject was "The Application of Brick to Paving Highways." At a dinner meeting held on February 24, speakers were Dean George W. Case of the College of Technology, and J. H. Kimball, sanitary engineer in charge of the Durham sewage disposal project. An inspection trip to Boston and Worcester, Mass., including many points of engineering interest in the two cities, was taken May 1–3.

University of New Mexico

Interesting and informative talks were given at the various meetings held during last year by the University of New Mexico Student Chapter. Among the topics discussed were: "Spillway Behavior," "The Coolidge Dam," "Air Purification," and "The Panama Canal."

American Society of Civil Engineers
New Mexico Section

Award

Be it Known by These Presents:

That in recognition of the high degree of scholarship attained during his college course in Civil Engineering at the University of New Mexico, and his activites in the New Mexico Student Chapter of the American Society of Civil Engineers,

Maurice Lipp

is hereby recommended for junior membership in the American Society of Civil Engineers with initiation fee fully paid. This award also includes the Junior Pin which will be presented upon completion of formal action by the parent Society upon regular application for said membership.

In accepting this award, it is hoped that the recipient will retain active membership with the society and accept the advanced grades of membership offered as he continues to grow in years, and in professional experience, and becomes eligible to this recognition.

Respectfully presented by the New Mexico Section of the American Society of Civil Engineers.

BY R. T. Stone, PRESIDENT

W. B. Reams, SECRETARY

Albuquerque, New Mexico, June 6, 1932

JUNIOR MEMBERSHIP CERTIFICATE PRESENTED BY THE NEW MEXICO SECTION TO A STUDENT CHAPTER MEMBER

University of Southern Calforinia

Members of the University of Southern California Student Chapter have had an interesting series of meetings during the last year. On one occasion, the Los Angeles Section held its meeting on the campus as guests of the Chapter. A tour of the campus was made and dinner was served. Among the speakers were Dr. Tieje, Professor Dodge, and Mr. Metcalf.

University of Texas

Meetings of the University of Texas Student Chapter, which took place twice each month during the year, were enthusiastically attended. At one of these gatherings, a talk on "The Testing of Soils for Pavements and Subgrades," was given by A. D. Potter, of the Department of Soils, of the State Highway Testing Laboratories.

University of Wisconsin

Among the informative talks given at the meetings of the University of Wisconsin Student Chapter held during the past semester, was one by Bert Hanson, a student, who told of his experiences while working in Venezuela and Colombia. On December 16, Warren J. Mead, Professor of Geology, gave an illustrated lecture on Hoover Dam.

Virginia Military Institute

Many meetings held by this Chapter during the past year were addressed by the student members, who spoke on a very interesting group of subjects. On several occasions there were outside speakers, among them the following: Mr. Mitchell, representative of the Linde Air Products Company; Professor Cunningham, of Harvard; Professor Gregory, of Johns Hopkins University; A. E. Crockett, of the Jones Laughlin Steel Company; and Dr. Faragher, representative of the Aluminum Company of America.

Virginia Polytechnic Institute

Programs of great interest were arranged for the meetings of the Virginia Polytechnic Institute Student Chapter held during the last year. These consisted of talks and illustrated lectures given almost exclusively by the students. There were two outside speakers—E. E. Barnard, consulting engineer of Lynchburg, who spoke to the Chapter on the licensing of engineers; and Prof. J. H. Gregory, of Johns Hopkins University.

Washington University

The Student Chapter of Washington University has had an interesting year. One meeting was devoted to the showing of films, and on another occasion, a joint meeting was held with the St. Louis Section. At this time the principal address was delivered by Colonel Jonah on "Development of Transportation." A reel of "Building New York's Newest Subway," was also shown. On May 13, a picnic followed an inspection trip to the Howard Bend Station of the St. Louis Water Works Division.

Washington and Lee University

Bi-monthly meetings of the Washington and Lee University Student Chapter held during the past school year offered interesting programs. Lectures were given on: "Recent Power Developments at Niagara Falls," "The Phosphate-Rock Industry," "The George Washington Memorial Bridge," "The Cascade Tunnel," and "The Coolidge Dam."

Worcester Polytechnic Institute

Among those who addressed meetings of this Chapter during the recent year were the following: Lester West, of the Eastern Bridge and Structural Company, who spoke on the structural steel work at the Worcester Municipal Auditorium; and A. B. Holmstrom, of the Norton Company, who chose as his subject the construction of factories in England by his company.

Yale University

Various interesting meetings of the Yale University Student Chapter have been held during the past year. At the meeting held on December 5, the late Prof. Howard E. Boardman, Dudley Professor of Railroad Engineering at Yale University, spoke on "Some Experiences and Typical Problems Which Confront Engineers." The speaker for the meeting of January 19 was Charles E. Smith, vice-president of the New York, New Haven, and Hartford Railroad; and on February 23, O. H. Ammann, Chief Engineer of the Port of New York Authority, gave an illustrated lecture on "The George Washington Bridge." The latter, which was a university lecture given under the auspices of the Student Chapter, drew an audience of over 600.

ITEMS OF INTEREST

Engineering Events in Brief

Construction League of U.S.

HAVING EMERGED from the formative stage, the Construction League of the United States has now become an active force for the unification and betterment of the construction industry. The membership, which is limited to 35 organizations, to date comprises the American Face Brick Association; the American Institute of Architects; the American Institute of Steel Construction; the Associated General Contractors of America; the Contracting Plasterers' International Association; the Electrical Guild of North America; the International Cut Stone Contractors' and Quarrymen's Association, Inc.; the International Society of Master Painters and Decorators, Inc.; the National Association of Marble Dealers; the National Association of Master Plumbers of the United States; the National Committee of Building Congresses; the Producers' Council, Inc.; and the American Society of Civil Engineers.

Officials of each national member of the Construction League are members of its assembly and can thus become acquainted directly with the broad objectives of the industry as a whole and can devise and cooperatively advance national programs. The league also is providing an agency through which a national association may appeal to other associations for aid in advancing one or more of the programs in which it is vitally interested.

The purpose of the Construction League is to marshal support for specific measures of benefit to the entire industry. The machinery for initiating and directing that support consists of a Policy Committee, five executive officers, and a joint secretariat of three. The Policy Committee is composed of the officers and two members of each of the associations participating. Tentative proposals may be placed before the Policy Committee at any time between meetings of the league and, if approved for support, will be recommended to all the participating organizations for suitable action. The construction industry has some very broad and definite problems to analyze and solve. It is possible to solve them only through united thought and action. For this the Construction League of the United States offers the means and gives promise of success.

Officers of the Construction League are R. D. Kohn of the American Institute of Architects, general chairman for a one-year term; Francis Lee Stuart, Past-President Am. Soc. C.E., first vice-chairman; A. P. Greensfelder, M. Am. Soc. C.E., a former president of the Associated General Contractors of America, second vice-chairman for a period of two years; J. C. Bebb, manager of the Otis Elevator Company, treasurer; P. W. Donoghue, president of the National Association of Master Plumbers of the United States, general secretary; and a joint secretariat consisting of E. C. Kemper, of the American Institute of Architects; Charles Upham, M. Am. Soc. C.E., of the American Road Builders Association; and Edward J. Harding, of the Associated General Contractors of America. The headquarters of the league is at 1741 New York Avenue, N.W., Washington, D.C.

Philadelphia Engineers Support Employment Service

THE ENGINEERS' Club of Philadelphia, supported by 12 affiliated engineering societies, has organized the Philadelphia Technical Service Committee for the purpose of assisting the employer of technical talent to secure the proper man for each opening, and of helping the unemployed engineer to find work. The cooperation of this committee with the Pennsylvania State Employment Commission assures its permanence.

There are 850 competent, trained men now registered with the committee; and the list, covering a wide range of activities, includes executives, plant engineers, process technicians, as well as salesmen, purchasing agents, designers, draftsmen, chemists, and others.

In addition to the placement work, a "job consultation service" is offered. Upon request, a technical employment specialist of wide experience will help the prospective employer to prepare his job specifications. This is to aid him in securing the best the field affords for the handling of his technical problems.

Manufacturers who are in need of technical assistance may communicate with the committee at the Engineers' Club, 1317 Spruce St., Philadelphia. The facilities of this organization are available entirely without cost to either employer or employee. All communications will be held strictly confidential.

Book on Regional Planning

IT WAS the late Senator Dwight W. Morrow who said: "We hear a good deal about the cost of planning. Somebody ought really to write a book upon the cost of not planning. It is quite demonstrable that the real cost in building up a community is the cost of non-planning."

According to *Regional Planning*, the carefully prepared and copiously illustrated volume recently published by the Regional Planning Federation of the Philadelphia Tri-State District, the Federation was incorporated in May 1928 to administer a fund of $600,000 raised by business and civic organizations to cover the cost of surveys and studies, and the preparation from them of a comprehensive regional plan. From the 1931 report of the federation it is noted that more than 700 individuals, companies, corporations, and utilities contributed to the fund. Because the city of Philadelphia is close to the boundaries of three states, the area embraced by the metropolitan district includes one county in Delaware, five counties in New Jersey, and five counties in Pennsylvania. In this area of 4,555 square miles, the joint needs of 400 separate political subdivisions are being taken into consideration.

Studies of the federation have concerned the use of land within this district; planning for the movement of passenger traffic on highways and by railroads and interurban lines; port requirements; freight handling; aviation facilities; housing for the citizens of the area; and water supply and sanitation. These studies now have been largely completed, and the regional plan, the work of 200 technicians, has been formulated. A digest of the plan is given in *Regional Planning*. This publication is being distributed as an aid in putting the plan in operation and for the information of other communities with similar problems. The executive director of the federation is William H. Connell, M. Am. Soc. C.E.

This book may be purchased for $10. A discount of 25 per cent, making the price $7.50, will be given to engineers, architects, lawyers, economists, and members of professions interested in planning work. Requests for copies should be mailed to the Regional Planning Federation, 1420 Walnut Street, Philadelphia, and should be accompanied by check.

Guggenheim Medal to Juan de la Cierva

IN RECOGNITION of his achievement in the development of the theory and use of the autogyro, Juan de la Cierva has just been awarded the Daniel Guggenheim Gold Medal for 1932. This award was made by a board composed of eight members from the United States and of several from foreign countries. The foreign countries represented are Canada, England, France, Germany, Holland, Italy, and Japan. All 15 members of the board have high standing in the world of aeronautics. Mr. de la Cierva is well known to the American public for his invention of the autogyro, "the windmill that flies." This machine has been developed and is being built for the market both in the United States and in Europe.

In the past, similar medals have been awarded to Orville Wright, of the United States; Ludwig Prandtl, of Germany; and Frederick William Lanchester, of England. The medal is awarded not oftener than once a year.

More Engineers Honored

SINCE the July issue went to press, notice has been received of other members of the Society upon whom engineering honors have been bestowed.

OSCAR VAN PELT STOUT, M. Am. Soc. C.E., recently received the degree of Doctor of Engineering from the University of Nebraska. In addition, the American Society of Agricultural Engineers awarded to Mr. Stout the first Cyrus Hall McCormick Medal, "for exceptional and meritorious engineering achievement in agriculture."

FRANK JULIAN SPRAGUE, M. Am. Soc. C.E., was elected during the past year to honorary membership in the American Institute of Electrical Engineers. He was honored by his engineering friends and representatives of the Founder Societies and other organizations at a meeting of appreciation and tribute held on July 25, in the Engineering Societies Auditorium.

LEON BENEDICT REYNOLDS, M. Am. Soc. C.E., was awarded the honorary degree of Doctor of Science by Hillsdale College, Hillsdale, Mich., in June 1932.

HANS KRAMER, Assoc. M. Am. Soc. C.E., received the degree of Doctor of Engineering from the Technical University of Dresden, Germany, on May 30, 1932. Lieut. Kramer's studies were pursued as a part of his two years of work in Europe as Freeman Fund Scholar representing the Society.

ARTHUR NEWELL TALBOT, Hon. M. Am. Soc. C.E., was recently awarded the Lamme Medal at the fortieth annual meeting of the Society for the Promotion of Engineering Education at Oregon State College, Corvallis, Ore. In the will of the late Benjamin G. Lamme, Chief Engineer of the Westinghouse Electric and Manufacturing Company, a fund was established to provide for the award of a medal to "a chosen technical teacher for accomplishment in technical teaching or actual advancement of the art of technical training."

HALVOR OLSEN HEM, M. Am. Soc. C.E., received one of the coveted honors in American science, when the Franklin Institute of Philadelphia presented to him the John Price Wetherill Medal. The award was made—"in consideration of the ingenuity shown in perfecting scales of the pendulum type, improving their accuracy, reliability, and sensitiveness, and for the application of these scales to specific purposes."

Aluminum for Dump Cars

TWO QUALITIES of aluminum always come to mind with mention of the name, its light weight and its freedom from rust or corrosion under many conditions.

Scientific and industrial research has had a large part in the somewhat romantic and spectacular progress of the adaptation of this metal to a great variety of practical uses. Not the least of the steps in this progress has been the development of strong and relatively hard alloys and methods for heat-treating them to improve their qualities for certain uses.

Aluminum means cooking utensils in the household; without its alloys aircraft would not be practicable on the present-day scale; business offices are becoming familiar with aluminum furniture; watches have been made of aluminum; pipes, steam radiators, and ornamental metal work are on the market; within two or three years even the conservative fields of railroad and highway transportation have been entered. Saving of weight and resistance to corrosion offer substantial savings, visible on the ledger. Hence the possibilities interest the financial as well as the operative branch of business management.

It costs as much to haul a pound of vehicle as a pound of pay load. It takes as much energy to get a pound of vehicle into motion, and it wears the brakes as much to stop a pound of vehicle as a pound of pay load.

Commerce requires transportation in large quantities of a number of solids and liquids which so rapidly corrode the metals heretofore practically available for cars that replacements were frequent and costly. Coal, sulfur, and certain acids are a few of the trouble-making but important cargoes.

In December 1931, the Alcoa Ore Company of Pittsburgh, Pa., put into service ten 70-ton hopper cars with aluminum bodies. They were used for hauling coal, sulfur, and bauxite, the ore of aluminum. They are 42 ft. long over-all, 40 ft. inside the body. Their inside width is $9\frac{1}{2}$ ft., and their height from rail to top of body is $10\frac{1}{2}$ ft. The running gear is of steel and iron, to satisfy existing regulations, although engineering considerations would have permitted aluminum for some of these parts, further reducing weight. Each car weighs 38,900 lb., or 21,200 lb. less than if built of the heavier, easily corrodible metals.

In selecting aluminum alloys, attention was given to strength and other structural requirements, to formability in making the cars, and to resistance to corrosion caused by atmosphere or cargo. The cars were successfully built and have been giving satisfaction in their brief service to date.

For the U. S. Bureau of Mines fuel yard in Washington, six automobile dumping trucks were built in 1931 to haul coal, with bodies wholly of aluminum, excepting the hoisting mechanism. These bodies are 11 ft. long, 7 ft. wide, and 3 ft. 9 in. high inside; they weigh 1,420 lb. each, 1,900 lb. less than if made of steel. Nearly a ton more coal can be hauled each trip. Each truck travels from 50 to 60 miles a day.

A fuel dealer in Providence, R.I., has a motor truck hauling coal and coke. Its all-aluminum body is 15 ft. long, $7\frac{1}{2}$ ft. wide, and 4 ft. 4 in. high inside, weighing 2,650 lb. and saving 1,600 lb. In Milwaukee, Wis., a fuel dealer has an aluminum-body truck in which the deadweight saving is 1,460 lb. This truck makes approximately seven trips a day, totaling approximately 45 miles. In 300 working days per year the increased pay load is equivalent to 30 days haulage in the former truck. Incidentally, the delivery spouts also are aluminum.

A large-capacity wheelbarrow, which is so light (37 lb.) that a girl can pick it up easily, is a back-saver for men wheeling sand, concrete, and other heavy materials. Such barrows, all aluminum but their axles, are on the market. Their resistance to corrosion is also an asset.

Aluminum dump-cars range, therefore, from 3-cu.-ft. wheelbarrows to 70-ton railroad cars. And there are tank cars, too.

From Research Narratives, The Engineering Foundation, May 15, 1932. Material contributed by Francis C. Frary, Ph.D., Director of Research, Aluminum Company of America, New Kensington, Pa.

Iron Alloy Research Continues

THROUGH its Committee on Research of Alloys of Iron, the Engineering Foundation has been making a critical survey of the whole field of iron and its many alloys. This survey, which is to cover the technical literature of the whole world from 1890 to date, is now more than half completed. Publication of the first monograph, *The Alloys of Iron Molybdenum*, will take place in the early autumn. A second monograph is complete, but not yet in print, and a third and fourth are partly done; two more have been started and plans for four others have been made. These monographs will cover research on alloys of iron with silicon, tungsten, copper, pure iron, nickel, chromium, vanadium, manganese, and carbon.

Proceedings of the Highway Research Board Now Available

THIS year the *Proceedings* of the Highway Research Board are bound in two volumes. Part I as usual contains the general papers and reports, while Part II consists of the final report of the special investigation on the "Use of Rail Steel Reinforcing Bars in Highway Construction." Both volumes are available to interested engineers at the regular subscription price of $2. Checks for this amount may be sent to the Highway Research Board, 2101 Constitution Avenue, Washington, D.C.

NEWS OF ENGINEERS

From Correspondence and Society Files

THEODORE W. FRIEDMAN, formerly Junior Highway Engineer, Construction Division, U.S. Bureau of Public Roads, Washington, D.C., is now Junior Civil Engineer, U.S. Engineer Office, Natchez, Miss.

L. BOYD MERCER has accepted an appointment as South American representative for the Jones-Hettelsater Construction Company, of Kansas City, Mo. He was previously Structural Engineer for Henry Simon, Ltd., in Buenos Aires.

ROLLEN J. WINDROW, previously vice-president of Smith Brothers, Inc., of Dallas, Tex., is now vice-president of the Southwest Construction Materials Company of that city.

J. WOULFE FLANAGAN, until recently Resident Engineer, Southend-on-Sea New Sewerage, Essex, England, has become connected with Messrs. Sheard, Breach, and Company of London.

JOHN A. MANCINI has accepted an appointment as City Engineer of Hayward, Calif.

R. W. GASTMEYER, former manager of the New York office of the Pittsburgh Bridge and Iron Works, is now in the employ of the H. H. Robertson Company of New York City.

P. A. SHAW has opened consulting offices in New York City. His former position was Hydraulic Engineer with the Trojan Engineering Corporation of New York.

WALTER A. BLUE has accepted a position with the Samuel Kraus Company of St. Louis. He was formerly Construction Superintendent for the J. A. Mercier Company of Detroit.

FRANK I. MARION has opened offices in Toledo, Ohio, as a consulting engineer.

EDWARD K. ALEXANDER is now with the Indiana State Highway Commission in Vincennes, Ind. He was formerly assistant engineer for the Peoria and Eastern Railway.

H. D. BRUNING, consulting engineer of Columbus, Ohio, has been appointed vice-president of the Hocking Valley Brick Company of Columbus.

EDWARD H. CAMERON, has become affiliated with the Arthur L. Nelson Engineers, of Boston, Mass., as a consulting engineer. He was formerly an engineer with Jackson and Moreland, also of Boston.

LYNN L. DAVIS is Resident Engineer in charge of sub-office, U.S. Engineers, Oswego, N.Y. He was formerly Principal Civil Engineer in the U.S. Engineer Office in Buffalo, N.Y.

GEORGE E. BARNES, former Designing Engineer for Fuller and McClintock of New York City, is now Assistant Engineer of Design, Engineering Division, Department of Sanitation, City of New York.

GILBERT R. FIELD is now a Junior Engineer in the U.S. Engineer Office, Upper Mississippi Valley Division, St. Louis, Mo.

W. E. LAND has accepted a position as assistant engineer with Lago Oil and Transport, Ltd., located in San Nicholas, Aruba, Dutch West Indies.

JOHN J. HARMAN has recently been appointed general secretary of the Manufacturers Standardization Society of the Valve and Fittings Industry of New York. Formerly Mr. Harman was research engineer for the Walworth Company of Boston.

FRED A. CAMP has entered the employ of the Bates and Rogers Construction Company of Belmont, N.Y.

J. W. JACKSON is now engaged in survey work with the U.S. Coast and Geodetic Survey. He was previously structural detailer and checker with the American Bridge Company of Gary, Ind.

SIDNEY A. REISS, formerly Engineering Assistant for the Board of Transportation, New York City, is now connected with the Department of Sanitation as Topographical Draftsman.

D. H. LEE has accepted an appointment to be Technical Director of the Ashton Construction Company, Ltd., Structural Steelwork Engineers of London. Until recently, Mr. Lee was Director, Eton Estates, Ltd., and Domiciles Ltd., London.

CONARD P. HUGHES is now employed by the White Eagle Oil Corporation of Minneapolis, Minn., as District Engineer.

NORMAN R. MOORE has resigned his position as assistant engineer with the Dayton Morgan Engineering Company of Springfield, Ohio, and is now assistant engineer for the Bureau of Construction, Ohio Department of Highways, with headquarters at Sidney, Ohio.

ARCH W. NAYLOR, formerly Chief Construction Engineer, Cia Constructora-Latino-Americano, S.A., Tampico, Tamps., Mexico, has resigned to become associated with the Ingenieros y Contratistas "Martin," S.A., Mexico, D.F.

DAVID MOLITOR has been made Construction Engineer for the supervising architect, in charge of construction of the new Federal Building in Bay City, Mich.

Changes in Membership Grades

Additions, Transfers, Reinstatements, Deaths, and Resignations

From June 10 to July 8, 1932

ADDITIONS TO MEMBERSHIP

BROWN, FRANCIS LEO (Jun. '32), Chainman, Constr., Field Party, D. & H. R. R. (Res., 10 Lafayette St.), Whitehall, N.Y.

BROWNE, FREDERICK LEE (Jun. '32), 9709 Warren St., Forest Glen, Md.

DORRANCE, WILLIAM TULLY, JR. (Jun. '32), 103 Armory St., New Haven, Conn.

DUNKLE, DUDLEY ANDREW (Assoc. M. '32), Vice-Pres. and Gen. Mgr., Am. Concrete Pipe Co. of Washington; 459 East 15th St., Tacoma, Wash.

GOODRIDGE, RICHARD SAMUEL (Assoc. M. '32), Hydrographer, Los Angeles County Flood Control Dist. (Res., 2636½ South Bronson Ave.), Los Angeles, Calif.

GRIFFIN, ROBERT HARDY (Jun. '32), Junior Engr., U.S. Forest Service, Ferry Bldg., San Francisco, Calif.

GRIGSBY, KLINE BURDETT (Jun. '32), Elvaston, (Hancock County), Ill.

HALL, BERT ANDREW (Assoc. M. '32), Associate Engr., U.S. Bureau of Reclamation, Box 1191, Boulder City, Nev.

HORWATH, THEODORE JOSEPH (Jun. '32), 920 Bergen St., Newark, N.J.

MORRISON, JOHN H. (Jun. '32), 626 Carlton Ave., Brooklyn, N.Y.

MOSKOWITZ, Karl (Jun. '32), 2900 Grove St., Berkeley, Calif.

MULLAN, ALBERT CHARLES (Jun. '32), 515 Sixty-seventh Ave., Philadelphia, Pa.

NOBLE, WILLIAM HENRY (Assoc. M. '32), Asst. Engr. (Civ.) U.S. Engr. Office, 707 Postal Telegraph Bldg., Kansas City (Res., Parkville), Mo.

PETERSON, BEN LEO (Assoc. M. '31), 510 South Palouse St., Walla Walla, Wash.

REYNOLDS, JOHN THOMAS (Jun. '32), 248 Euclid Ave., Ridgefield Park, N.J.

SNYDER, LAWRENCE KING (Jun. '32), 1008 Oak St., Rolla, Mo.

SPERLING, ELMER JOHN (Jun. '31), 732 William St., Cape Girardeau, Mo.

STAPLES, LEROY AUGUSTUS (Assoc. M. '32), Asssociated with George P. Rice. (Res. 5101 Pitt St.), New Orleans, La.

STRIEBECK, WILLIAM HERBERT, JR. (Assoc. M. '32), Res. Engr., State Highway Dept., George West, Tex.

MEMBERSHIP TRANSFERS

BOATNER, MARK MAYO, JR. (Assoc. M. '30; M. '32), Lieut., Corps of Engrs., U.S.A. Asst. to Dist. Engr., 2d New Orleans Dist., U.S. Engr. Office, Foot of Prytania St., New Orleans, La.

BURKE, WALTER ANTHONY, JR. (Jun. '29; Assoc. M. '32), Treas., Thos. Crimmins Contr. Co. (Res., 1220 Park Ave., Apartment 3-B), New York, N.Y.

DUVALL, ARNDT JOHN (Jun. '26; Assoc. M. '32), Engr., Toltz, King & Day, Inc. (Res., 250 South Syndicate Ave.), St. Paul, Minn.

FOSTER, HENRY ALDEN (Assoc. M. '22; M. '32), Asst. to Chf. Engr., Parsons, Klapp, Brinckerhoff & Douglas, 142 Maiden Lane, New York, N.Y. (Res., 266 Tichenor Ave., South Orange, N.J.)

HALL, WARREN ESTERLY (Jun. '07; Assoc. M. '10; M. '32), Civ. Min. and Hydr. Engr. (B. M. Hall & Sons), 701 Peters Bldg., Atlanta, Ga.

HAW, ELMER PERKINS (Assoc. M. '15; M. '32), with Dredging Div., Panama Canal, P.O. Box 292, Ancon, Canal Zone.

KROENING, WALTER EDWIN (Jun. '29; Assoc. M. '32), Senior Engr., Sewerage Comm., City of Milwaukee, Jones Island, Milwaukee, Wis.

MCPHAIL, DONALD STUART (Assoc. M. '23; M. '32), care, Barclay's Bank (Dominion Colonial and Overseas), 29 Grace Church St., London E.C.3, England.

MORRISS, BENHAM EPES (Jun. '27; Assoc. M. '32), Area Revetment Insp., U.S. Engrs., Board of Trade Bldg., Cairo, Ill.

SHU, RUF (Jun. '26; Assoc. M. '31), Head, Civ. Eng. Dept., Hangchow Christian Coll., Zakow, Che, China.

SMITH, CHESTER WASON (Assoc. M. '04; M. '32), Operations Engr., U.S. War Dept., U.S. Engr. Office, Huntington, W.Va.

THOMAS, WALLACE ANDREWS (Jun. '29; Assoc. M. '32), Asst. City Engr. (Res., 146 North Clay Ave.), Ferguson, Mo.

THOMPSON, T. SANFORD (Jun. '23; Assoc. M. '32), Designer, Merritt-Chapman & Scott Corporation, 17 Battery Pl., New York (Res., 947 Eightieth St., Brooklyn), N.Y.

WILLIFORD, CARL LEX (Assoc. M. '21; M. '32), Res. Engr., State Highway Dept., 320 Records Bldg., Dallas, Tex.

WILSON, PERCY SUYDAM (Jun. '21; Assoc. M. '24; M. '32), Supt. of Operation, Community Water Service Co., 46 Cedar St., New York, N.Y.

WINCHESTER, THOMAS HARRISON (Jun. '09; Assoc. M. '13; M. '32), Engr., Georgia Power Co. (Res., 119 Vista Circle), Macon, Ga.

RESIGNATIONS

BILLINGS, CHARLES NEWPORT, Assoc. M., resigned June 30, '32.

BUCHANAN, GEORGE HENRY, Assoc. M., resigned July 7, '32.

CARTWRIGHT, FRANK POOLE, Assoc. M., resigned July 7, '32.

ENGLE, AMOS BRENEMAN, Assoc. M., resigned July 6, '32.

JONES, JOHN EARL, M., resigned July 6, '32.

MAGEE, BRONSON ROY, Assoc. M., resigned July 1, '32.

MARPLE, GARLAND EMMETT, Jun., resigned July 7, '32.

MOSS, ROBERT FAULKNER, Assoc. M., resigned June 15, '32.

NEELY, JOHN THOMPSON, Assoc. M., resigned June 20, '32.

NIELSEN, JENS EGEDE, Assoc. M., resigned July 6, '32.

PURNELL, RAYMOND GEORGE, Jun., resigned June 13, '32.

TEIS, KENNETH ROBERT, Assoc. M., resigned July 1, '32.

REINSTATEMENT

TOUCEDA, ENRIQUE AUGUSTO, M., reinstated June 15, '32.

DEATHS

BATTYE, BASIL CONDON. Elected M., Apr. 25, 1921; date of death unknown.

GRANT, EMERSON WARREN. Elected M., Dec. 4, 1889; died May 6, 1932.

JOHNSON, BENJAMIN OLIVER. Elected M., July 9, 1923; died June 27, 1932.

KEIM, WARREN BYRON. Elected Assoc. M., Jan. 4, 1905, M., Apr. 26, 1921; died June 2, 1932.

LIMA CAMPOS, ARTHUR FRAGOSO DE. Elected Assoc. M., Mar. 16, 1925; died April 26, 1932.

MERRILL, GEORGE NATHAN. Elected M., May 1, 1889; died June 22, 1932.

NEWELL, FREDERICK HAYNES. Elected M., Dec. 5, 1900; died July 5, 1932.

OKUMURA, KANJI. Elected M., July 11, 1921; died April 17, 1932.

POLAND, JOHN FREDERICK. Elected Assoc. M., Aug. 31, 1915; died March 7, 1932.

SHEEHAN, WILLIAM FRANCIS. Elected Assoc. M., Mar. 16, 1925; died June 14, 1932.

SPERLING, ROBERT SIGISMOND. Elected Jun., Oct. 1, 1928; died April 11, 1932.

TEFFT, WILLIAM WOLCOTT. Elected Jun., Mar. 31, 1908, Assoc. M., Jan. 2, 1912, M., Oct. 10, 1916; died June 24, 1932.

VAN HORNE, JOHN GARRET. Elected M., Feb. 4, 1880; died June 7, 1932.

WARDLE, JOSEPH DOMAN. Elected M., July 6, 1920; date of death unknown.

TOTAL MEMBERSHIP AS OF JULY 8, 1932

Members	5,861
Associate Members	6,384
Corporate Members	12,245
Honorary Members	17
Juniors	2,964
Affiliates	122
Fellows	5
Total	15,353

Men Available

These items are from information furnished by the Engineering Societies Employment Service with offices in Chicago, New York, and San Francisco. The Service is available to all members of the contributing societies. A complete statement of the procedure, the location of offices, and the fees is to be found on page 97 of the 1932 Year Book of the Society. Unless otherwise noted, replies should be addressed to the key number, Engineering Societies Employment Service, 31 West 39th Street, New York, N.Y.

CONSTRUCTION

CIVIL ENGINEER; Jun. Am. Soc. C.E.; 29; single; B.S. in C.E.; 2½ years in construction department of railroad; 1½ years on reinforced concrete building construction; 3 years experience on deep-shaft rock tunnel for water supply, subaqueous subway tunnel, and compressed air. Desires position with construction company or consulting engineer, field or office. Available immediately. Location and salary open. C-918.

GRADUATE CIVIL ENGINEER; Assoc. M. Am. Soc. C.E.; member New York State Society of Professional Engineers; licensed professional engineer and land surveyor, New York State; 6 years in responsible charge of structural design and as resident engineer on construction of sewage treatment plants. Connection with contractor or consulting engineer preferred. C-2907.

CIVIL ENGINEER AND SURVEYOR; Jun. Am. Soc. C.E.; 33; registered engineer and land surveyor; college graduate; 3 years experience on subdivisions, municipal work, sewers, and roads; 6 years experience on subway and building construction as field engineer, assistant designer, and estimator. Will work any place in United States. C-130.

GRADUATE ENGINEER; Assoc. M. Am. Soc. C.E.; 36; single; registered in two states. Experienced in highway and bridge construction (concrete), office and field, and as resident engineer on large industrial plants with large engineering and construction organization. Some experience in field design of concrete and steel. Location immaterial. Available immediately. D-1100.

CIVIL ENGINEER; Assoc. M. Am. Soc. C.E.; 33; married; New York State license; 8 years experience building construction, office and industrial types; field supervision and office engineering, including design, drafting, and specifications. C-7048.

GRADUATE CIVIL ENGINEER; Assoc. M. Am. Soc. C.E.; 8 years varied structural experience, drafting, design, and construction; inspection, surveys, layouts, for steel and concrete structures and track work. Capacity to assume responsibility. Desires any suitable connection, preferably with construction company, consultant, contractor, or architect, in field or office; also sales-engineering or instructorship. C-2605.

SUPERINTENDENT OF CONSTRUCTION; Assoc. M. Am. Soc. C.E.; 42; married; technical graduate; 20 years experience in building construction—10 years designing, 10 years as superintendent. Foundations, underpinning, industrial plants, public buildings, factory, and office buildings. Able executive and good organizer. Available now. Location in the East. B-2288.

DESIGN

CIVIL ENGINEER; Assoc. M. Am. Soc. C.E.; 35; married; B.S. and M.S. in C.E.; 2 years highway plans; 1 year structural steel detailing; 7 years designing and detailing steel and reinforced concrete structures. Desires teaching or engineering work. D-1093.

CIVIL AND SANITARY ENGINEER; Jun. Am. Soc. C.E.; 25; single; B.S. in C.E.; M.S. in San.E.; 3 years sanitary engineering experience; assistant to consulting engineer on sanitary surveys and sewerage designs. Sanitary engineer for a city in responsible charge of design and supervision of construction of small sewage treatment plant. D-1088.

STRUCTURAL ENGINEER; Assoc. M. Am. Soc. C.E.; 32; married; B.S. in C.E.; 10 years varied experience in structural steel and reinforced concrete bridge design; last 4 years assistant squad boss for bridge department of railway. D-1190.

STRUCTURAL ENGINEER; Assoc. M. Am. Soc. C.E.; 31; married; graduate of Lehigh University, 1924; 1 year in graduate school of University of Illinois; 7½ years broad experience in drafting, designing, and estimating departments with engineers and fabricators on bridges and buildings of all types. Desires position as designer, assistant engineer, or sales engineer in steel or reinforced concrete. C-7922.

EXECUTIVE

EXECUTIVE, CONSTRUCTION, DESIGNING ENGINEER; Assoc. M. Am. Soc. C.E.; 44; married; licensed professional engineer, New York; C.E. degree; 10 years experience supervising design, field construction, and public works, including bridges, buildings, and tunnels; 3 years with firm of industrial engineers; 4 years as general manager of large firm engaged in general contract work, bridges, buildings. Desires position where executive and business ability are required. Available. D-1048.

CIVIL ENGINEER; Assoc. M. Am. Soc. C.E.; married; technical graduate; 16 years experience in sanitary and municipal work of various kinds, including design and construction of sewage treatment and water purification plants, appraisals, preliminary investigations, and reports. Recently completed supervision of large filter plant. Desires connection with contractor or consulting engineer. D-1118.

GRADUATE CIVIL ENGINEER, 1922; Jun. Am. Soc. C.E.; 30; 3 years construction experience; 7 years as engineer in technical departments of two cement companies. Duties consisted of consultation with customers, cooperation with engineers and architects on concrete problems, promotion of products, design of mixtures for ready-mix concrete, and office correspondence. C-370.

CIVIL OR HYDRAULIC ENGINEER; M. Am. Soc. C.E.; 36; married; 11 years experience—9 in responsible charge of hydraulic and structural design of sewerage works, costing about $24,000,000, and experimenting, investigating, reporting, writing specifications, and preparing estimates for sewer contracts. Also, 2 years of varied construction experience. Available at once. D-1132.

CIVIL ENGINEER; Assoc. M. Am. Soc. C.E.; 43; single; one dependent. Registered civil engineer and licensed surveyor, State of California. Varied experience in construction, design, and teaching in university. Good health, active, energetic. Desires employment as civil engineer, designer, or executive. Detailed experience on request. Immediately available. San Francisco Bay region preferred. D-1139-325-A-16 San Francisco.

MASTER OF CIVIL ENGINEERING GRADUATE; Jun. Am. Soc. C.E.; 29; single; 6 years experience—2 years harbor engineering, warehouses, wharves, grain elevators, turning basins, and freight yards; 2½ years reinforced concrete reservoirs, highway bridges, grade crossing problems, arches, and rigid frame design; 1½ years on school buildings, power houses, prisons, hospitals, and armories. Desires position. D-1102.

CIVIL ENGINEER; Assoc. M. Am. Soc. C.E.; B.S. in C.E.; B.S. in M.E.; M.S. in C.E., Georgia School of Technology; 6 years paving contractor; 4 years assistant city engineer; 2 years city engineer; 1 year field engineer; 1 year college instructor. D-1117.

CIVIL ENGINEER; Assoc. M. Am. Soc. C.E.; 31; married; B.A., B.S., and C.E. degrees; 10 years broad general experience, including teaching, surveys, design and construction of highways, bridges, industrial buildings, steam and hydro-electric power plants, dams, river, and harbor improvements, drainage, municipal improvements. Now employed. Prospect of advancement above salary. Will go anywhere. C-8715.

EXPERT on sewage and industrial wastes disposal and stream pollution; Assoc. M. Am. Soc. C.E.; 10 years experience and accumulated data. Formerly connected with largest disposal program in United States. Qualified to investigate, study, report, design, supervise operation and construction, and take charge of or advise on all phases of sewage disposal. Permanent or temporary work desired. D-1161.

CIVIL ENGINEER; M. Am. Soc. C.E.; 44; married; university graduate; 21 years experience in design, construction supervision, contracting on railroad construction, bridges, buildings, foundations, grading, drainage, sewerage, water supply, etc. Expert on cost estimates, construction plant, organization and control, purchasing, and subcontracts. Responsible permanent position desired. B-548.

CIVIL ENGINEER; Assoc. M. Am. Soc. C.E.; 35; C.E. degree; New York license; 17 years experience in construction, design, and layout of industrial plants, copper refineries, smelters, furnaces, heavy machinery, structural steel, and foundations. Can take full charge of drafting room and get work out economically. B-5715.

ARCHITECTURAL ENGINEER; Assoc. M. Am. Soc. C.E.; 37; graduate of University of Illinois; 15 years thorough experience—10 years in responsible charge, covering the design, construction, estimates, and specifications on industrial buildings, factories, warehouses, college buildings, schools, and banks. Desires responsible connection with industrial firm, contractor, architect, or engineer. Location, New York City. D-1148.

CHIEF ENGINEER; M. Am. Soc. C.E.; manager of engineering, construction manager; competent executive; 20 years responsible industrial experience; proved reputation in development, investigation, design, construction, maintenance, production efficiency, and reorganization; desires opportunity to produce results with progressive company. B-3914.

INDUSTRIAL ENGINEER AND ARCHITECT; M. Am. Soc. C.E.; graduate; licensed; 20 years experience in design and construction of chemical and other industrial plants, hydro-electric developments, housing groups, commercial garages, all water and sewer systems, and other utilities in connection therewith. Organization and supervision of office and field forces. Preliminary investigations and reports. B-2835.

CONSTRUCTION OR OFFICE ENGINEER; Assoc. M. Am. Soc. C.E.; 40; married. Varied construction experience. Can take charge of development from preliminary survey to complete construction. Just finished $3,000,000 Santo Domingo railroad, highway, drainage, and building program. Speaks Spanish. Can take charge of office as chief draftsman or office engineer. Immediately available. Location immaterial. D-1193.

STRUCTURAL ENGINEER EXECUTIVE; M. Am. Soc. C.E.; 45; married; over 23 years experience in fabricating business, qualified to supervise any department. Specialized in efficient handling of estimating department and economical design. Also, experienced district sales manager, western Pennsylvania and Ohio district. Familiar with general building construction. Desires opportunity to communicate with persons interested. C-5095.

CIVIL AND STRUCTURAL ENGINEER; Assoc. M. Am. Soc. C.E.; married; licensed professional engineer, State of New York; 25 years experience in design and construction of hydro-electric and steam power plants, transmission lines, industrial plants, electric railways, estimates, specifications, and purchasing. Desires responsible charge of work. Location New York. B-5423.

ENGINEER; M. Am. Soc. C.E.; 41; industrial, mechanical, and construction. Complete industrial plants and power stations. Investigations, reports, planning, design, mechanics, building, construction, operation, and selling. Justified plant improvements and economic layouts, manufacturing methods and processes. Engineering reports for use in connection with mergers, consolidations, and sale or purchase of industrial and other properties. Satisfactory references. A-1185.

JUNIOR

CIVIL ENGINEER; Jun. Am. Soc. C.E.; 24; graduate of Drexel Institute; passed U.S. Civil Service examination for Junior civil engineer and Junior cartographic engineer. Experienced in field and office on property and topographic surveying, park development, highway construction, and earth-fill dams. Desires position in any branch. Available immediately. D-1092.

JUNIOR CIVIL ENGINEER; Jun. Am. Soc. C.E.; 24; single; B.S. and M.S. from Oregon State College. Passed U.S. Civil Service examination for junior engineer. Experience on construction work during vacations. Also experienced stenographer and typist. Will accept such position in engineer's or contractor's office. Available immediately. Location immaterial. D-1170-326-A-5.

CIVIL ENGINEER; Jun. Am. Soc. C.E.; 24; single; graduate of Stanford University; 2½ years experience with fabricators of structural steel products, tanks, and steel pipe lines, including experience in shop maintenance and production. Desires position in any line of civil engineering. Available at once. San Francisco Bay region preferred, if possible. D-1174-326-A-11-San Francisco.

CIVIL ENGINEER; Jun. Am. Soc. C.E.; 25; single; B.E. in C.E. from Johns Hopkins University; 8 months experience in railroad engineering office; 9 months on bridge construction work; 3 months surveying. Location immaterial. Salary secondary. D-1191.

CIVIL ENGINEER; Jun. Am. Soc. C.E.; 26; graduate of Carnegie Institute of Technology; instructor in calculus; 5 years of public utility experience on investigation of hydro-electric developments, including hydrographic and power studies, preparation of drawings for license application, preliminary design, cost analysis, and comparison with alternate steam developments. Also investigation of inter-connection of group or neighboring power companies. Available immediately. D-1157.

TEACHING

ASSOCIATE PROFESSOR STRUCTURAL ENGINEERING; Assoc. M. Am. Soc. C.E.; married; degrees B.S., M.S., and C.E. from University of Illinois; 3 years experience teaching major courses, structural theory, design, in ranking university; 5 years practice, reinforced concrete and steel structures—chiefly Waddell and Hardesty, consultants—cantilever, arch, suspension, movable, and continuous-girder spans; technical writer; world traveler. Desires position, leading university. D-330.

ENGINEER; M. Am. Soc. C.E.; 52; bachelor's degree in law, mechanical and civil engineering; M.S. in municipal and highway engineering; 8 years teaching; 18 years engineer-executive experience in highway, railway, bridge, building, drainage, and flood control construction. Wants position as dean, professor, or associate professor of civil, highway, or municipal engineering, anywhere. B-6357.

GRADUATE ENGINEER; Assoc. M. Am. Soc. C.E.; 32; married; 1 year instructor in machine design, large Eastern university; 4½ years on design and 4 years on construction of hydro-electric and steam power plants; 1½ years on design of industrial plant equipment; desires position teaching civil or mechanical engineering subjects. D-880.

CIVIL ENGINEER; Assoc. M. Am. Soc. C.E.; registered C.E.; B.S. and M.S. degrees; 8 years experience in hydraulics, sanitary, municipal, and structural engineering, including responsible charge of design and construction of large buildings, bridges, water power development, sewerage, water supplies, and street paving. Since 1929 with large Eastern university as instructor. C-6056.

RECENT BOOKS

New books of interest to Civil Engineers, recently donated by the publishers to the Engineering Societies Library, will be found listed here. A comprehensive statement regarding the service which the Library makes available to members is to be found on page 87 of the Year Book for 1932. The statements made regarding the books are taken from the books themselves and this Society is not responsible for them.

MODERN SEWAGE TREATMENT. By T. P. Francis. London, Contractors' Record, 1932. 322 pp., illus., diagrs., charts, tables, 10 × 6 in. cloth, 25s.

This treatise, which is the work of an experienced British designer of sewage works, is intended primarily for municipal and sanitary engineers, but will also prove of use to students and managers of sewage works. The various methods of sewage treatment and disposal are described in a clear, practical manner, and a number of British works are described in detail. Appendixes are devoted to sewage chemistry, the theory of colloids, and other pertinent topics. There are over 100 unusually good illustrations.

PLANNING FOR RESIDENTIAL DISTRICTS. Edited by J. M. Gries and J. Ford. President's Conference on Home Building and Home Ownership, Washington, D.C., 1932. 227 pp., illus., diagrs., tables, maps, charts, cloth, $1.

This volume contains the final reports of four committees of the President's Conference on Home Building and Home Ownership—those on City Planning and Zoning, Subdivision Layout Utilities for Houses, and Landscape Planning and Planting. These reports are a compact presentation of principles and practices, which will be most interesting to planning commissions, public officials, civic improvement associations, and home owners. The various committees are made up of well known specialists in each field, and their findings are the result of wide experience.

STAHLHOCHBAUTEN. By F. Bleich. Berlin, J. Springer, 1932. 558 pp., diagrs., charts, tables, 11 × 8 in., leather, 66.50 rm.

The first of two volumes upon the design and construction of steel buildings. This volume includes the general theoretical principles of steel construction and also presents necessary information concerning stresses and the strength of materials. The subject of steel construction is thoroughly covered, and the book gives a good picture of European practice.

STRESSES IN FRAMED STRUCTURES. Pt. 1. Design of Steel Mill Buildings. By M. S. Ketchum. New York and London, McGraw-Hill Book Co., 1932. 217 pp., diagrs., charts, tables, 9 × 6 in., cloth, $2.50.

This book covers the calculation of the stresses in simple beams, trusses, portals, the transverse bent, and the three-hinged arch, and is intended as a beginning course in the subject. Forty problems which cover the calculation of stresses in practically all types of simple roof and bridge trusses, bents, and portals are solved. Both algebraic and graphic methods of calculation are given. The book is reprinted from the author's *Design of Steel Mill Buildings.*

ZUR FRAGE DER KÜNSTLICHEN BAUAUSTROCKNUNG. (Mitteilungen des Forschungsinstituts für Maschinenwesen beim Baubetrieb, Heft 2.) By R. Dittrich and D. Rösslein. Berlin, VDI-Verlag, 1932. 16 pp., illus., diagrs., charts, tables, 12 × 8 in., paper, 4.50 rm.

Artificial drying of buildings during construction has attracted increasing attention in Germany during recent years, and in 1931 preliminary experiments were made by the Forschungsinstitut to determine the value of drying and its effect upon masonry. The results of these tests are presented and discussed in this report, with a program for further studies.

CURRENT PERIODICAL LITERATURE

Abstracts of Articles on Civil Engineering Subjects from Magazines in This Country and in Foreign Lands

Selected items from the current Civil Engineering Group of the Engineering Index Service, 29 West 39th Street, New York, N.Y. Every article indexed is on file in The Engineering Societies Library, one of the leading technical libraries of the world. Some 2,000 technical publications from 40 countries in 20 languages are received by the Library and are read, abstracted, and indexed by trained engineers. With the information given in the items which follow, you may obtain the article from your own files, from your local library, or direct from the publisher. Photoprints will be supplied by this library at the cost of reproduction, 25 cents per page, or technical translations of the complete text may be obtained when necessary at cost.

BRIDGES

BASCULE, NEW JERSEY. Skew Bascule Erection Complicated Job, J. H. Townsend. *Eng. News-Rec.*, vol. 108, no. 22, June 2, 1932, pp. 794 and 795. Erection of diamond-shaped single-leaf bascule bridge between Princeton and Trenton, N.J., having a long diagonal of 207 ft.; span erected in open position; floor beams and girders more than 100 ft. long had to be placed flat or inclined, thereby requiring careful shoring and bracing.

CONCRETE ARCH. Construction of Concrete Arches in Allegheny County, Pennsylvania, V. R. Covell. *Am. Concrete Inst.—Journal*, vol. 3, no. 10, June 1932, pp. 653–664. Construction of George Westinghouse Bridge, Pittsburgh, Pa., and of six smaller bridges on Ohio River Boulevard, at Pittsburgh; forms and centering; winter concreting plan and methods; use of crushed stone aggregate; high early strength cement; material inspection.

CONCRETE ARCH, GREAT BRITAIN. Oich Bridge. *Concrete and Constr. Eng.*, vol. 27, no. 5, May 1932, pp. 298–301, two supp. pages. Design and construction of 3-span reinforced concrete bridge arches built on a 70-deg. skew, a grade of 4½ per cent, and having clear spans of 58, 66, and 77 ft.

CONCRETE GIRDER, CANADA. Concrete Bridge in Welland Built with Unusual Rapidity. *Contract Rev.*, vol. 46, no. 22, June 1, 1932, pp. 631–635. Construction of North Main St. Bridge in Welland, Ont., built during the winter as an unemployment relief measure; structure is composed of four spans, each 48 ft. 4½ in. long; roadway 36 ft. clear between curbs; bridge is supported on wooden piles from 40 to 50 ft. in length; details of piers.

GREAT BRITAIN. New Chiswick Bridge. *Engineering*, vol. 133, no. 3464, June 3, 1932, p. 665. River is crossed by three arches, of which the central has a 150-ft. span between springings; two side spans with a clearance of 125 ft. each; the width of the bridge, which is 70 ft. between parapets, accommodates roadway 40 ft. wide with two 15-ft. pathways; cellular construction adopted for arch vaults, which measure 4 ft. 8 in. deep at springings and 3 ft. at mid-span; three arches were built simultaneously.

HIGHWAY, RECONSTRUCTION. Reconstruction of Bridge Over New Main Road, A. H. Cantrell. *Surveyor*, vol. 81, no. 2102, May 6, 1932, p. 485. Methods adopted in demolition of existing 25-ft. span brick archway and construction of 60-ft. span bridge in place of it. Before Inst. Civ. Engrs.

LIFT. Longest Railway Lift Bridge Is Built by M. K. T. Railroad. *Eng. News-Rec.*, vol. 108, no. 21, May 26, 1932, pp. 755 and 756. Description of recently completed lift bridge at Boonville, Mo., having a lift span of silicon steel, 408-ft. long; methods of construction; operating mechanism.

OREGON. Rogue River Bridge at Gold Beach, Oregon, W. A. Scott. *West. Construction News and Highways Bldr.*, vol. 7, no. 10, May 25, 1932; pp. 281 and 282. Features of a highway bridge consisting of seven concrete-arch spans, of 230 ft. each, and two 144-ft. concrete approach spans of bent and girder type; Freyssinet method of decentering and arch adjustment was used.

STEEL, DESIGN. Notes on Steel Highway Bridges, T. C. Grisenthwaite. *Structural Engr.*, vol. 10 (New Series), no. 5, May 1932, pp. 218–233. Design of steel highway bridges with spans up to 250-ft.; distribution of loading; floors; properties of steel joist-concrete slabs; reinforced concrete slab decks; jack arch floors; plate girder bridges; deck plate girders; frame, cantilever, and arch bridges; temperature stresses; errors involved in use of approximate formula; esthetic design.

STEEL, GREAT BRITAIN. New Lambeth Bridge. *Engineer*, vol. 153, no. 3987, June 10, 1932, pp. 630–632. Bridge replaces old wire-rope suspension bridge over the Thames River; has a total length of 776 ft. and consists of 5 spans; deck has a 36-ft. roadway and two 12-ft. pathways: central span measures 165 ft. and is flanked on each side by spans of 149 and 125 ft.; each is composed of nine steel arched ribs; erection was carried out by means of 20-ton cranes set up on piers and abutments.

SUSPENSION, MODELS. Suspension Bridge Stresses Determination by Model, G. E. Beggs, E. K. Tinby, and B. Birdsall. *Eng. News-Rec.*, vol. 108, no. 23, June 9, 1932, pp. 828–832. Application of model study to Mt. Hope Bridge, with a 1,200-ft. main span, gave results so close to analytical values that model analysis was adopted for preliminary and check design of Trans-Bay Bridge at San Francisco; principles of model analysis; musical tensometer used to determine variation of suspender pull; maximum positive bending moments in stiffening.

WELDING. Bridge and Structural Engineering Congress. *Engineer*, vol. 153, no. 3986, June 3, 1932, pp. 620 and 621. Account of Congress of International Association in Paris; review of paper by Caldwell on welding in steel structural work—British practice; and report on arc welding in bridge work in Australia.

BUILDINGS

CHICAGO. Pre-Fabricated Buildings Will Bring Lower Costs, A. T. North. *Am. Architect*, vol. 141, no. 2607, May 1932, pp. 66–67 and 90. Pre-Fabrication of steel houses; pre-fabricated steel units of dome of Travel and Transport Building at Chicago World's Fair.

DOMES. Parallel Trusses Carry Dome of Cincinnati Station, O. S. Payzant. *Eng. News-Rec.*, vol. 108, no. 23, June 9, 1932, pp. 817–820. Semi-dome steel-frame roof of new union station; parallel arched trusses, largely of H-section members and of varying spans, are placed at different elevations to fit curved outline of dome, while highest and largest trusses carry barrel arch; maximum external span is 202 ft. for dome and 209 ft. for barrel arch; layout of steel framing.

HIGH BUILDINGS, DESIGN. Deflections and Vibrations in High Buildings, L. J. Mensch. *Am. Concrete Inst.—Journal*, vol. 3, no. 10, June 1932, pp. 679–680. Discussion of article previously indexed from issue of Feb. 1932; author's closure.

STEEL, WELDED. Assuming Responsibility for Structural Welding, E. E. Seelye. *Eng. News-Rec.*, vol. 108, no. 21, May 26, 1932, pp. 769–771. Outline of precautions and procedures found useful in construction of welded quadrangle dormitory at Yale University; typical details; limits placed on design; inspection; weld connections.

CITY AND REGIONAL PLANNING

ROME, ITALY. Le nouveau plan d'aménagement et d'extension de la ville de Rome, G. Tian. *Génie Civil*, vol. 52, no. 24, June 11, 1932, pp. 588–592. Outline of 1925 and 1931 projects for replanning and extension of city of Rome, involving considerable demolition of buildings and construction of new thoroughfares.

STREET TRAFFIC CONTROL. Traffic Requirements Determine One Trend in City Development, D. G. Mickle. *Eng. News-Rec.*, vol. 108, no. 21, May 26, 1932, pp. 759–760. Summary of studies made in many cities in the United States; street traffic requires greatly enlarged facilities; separation of through from local traffic, provision of storage for cars, alley loading of trucks, and subsurface pedestrian walks; future cities.

CONCRETE

BEAMS, CONCRETE. Simplifying Reinforced Concrete Beam Design, O. Albert. *Eng. News-Rec.*, vol. 108, no. 24, June 16, 1932, pp. 860 and 861. Outline of original method; by use of special equations and constants steel areas are determined with only three lines of computation; charts for checking and estimating.

CONCRETE AGGREGATES. Refined Aggregate Production for Hoover Dam Concrete. *Eng. News-Rec.*, vol. 108, no. 22, June 2, 1932, pp. 783–787. Equipment for control of aggregates for 4,500,000 cu. yd. of concrete, providing sufficient flexibility to permit doubling capacity of plant from 500 to 1,000 tons per hour, operating either wet or dry, and increasing live storage; aggregate transportation; screening plant; flow diagram of aggregate plant from raw-gravel track hopper to carloading of finished product.

CONSTRUCTION, FORMS. Water-Tight Forms for Good Concrete, G. Hockensmith. *Constructor*, vol. 14, no. 5, May 1932, pp. 22 and 23. Leaking forms produce rough, porous surface subject to disintegration; fir veneer used as lining for concrete forms provides water-tightness and smooth surfaced concrete.

DISINTEGRATION. Weathering Resistance Concrete, E. J. Kilcawley. *Rensselaer Polytechnic Inst.—Bul.*, no. 36, Mar. 1932, 49 pp. Detailed reports of tests on the effect of certain proportions of colloidal clay on the strength, permeability, and weather resistance of concrete; continued freezing and thawing will decrease compressive strength and will be more pronounced in leaner mixes of concrete; effect of replacement of 10 per cent of the cement with clay.

MIXING. Fundamentals of Cement Concrete—I, J. M. Portugais. *Can. Engr.*, vol. 62, no. 24, June 14, 1932, pp. 9–10 and 43. Classification of cements; fundamentals of good concrete; strength and durability factors; water-cement ratio law; manufacture in field; quantities of materials.

SPECIFICATIONS. Bins, Batchers; Handling and Weighing Bulk Cement—Standardization of Weighing Devices for Concrete Aggregate. *Eng. and Contracting*, vol. 71, no. 5, May 1932, pp. 135 and 136. Specifications by American Road Builders' Association for bin-batcher type of equipment for weighing aggregates; equipment requirements; arrangement and operation.

STRENGTH. Tests on Consistency and Strength of Concrete Having Constant Water Content, I. Lyse. *Am. Soc. Testing Material—Advance Paper*, no. 60, meeting June 20–24, 1932, 8 pp. Data showing that the consistency of concrete remains nearly constant regardless of richness of mix, if type and graduation of aggregates and water content per unit of fresh concrete remain constant.

TESTING. Stress-Strain Relations in Concrete, J. Gilchrist, R. H. Evans, and T. Whitaker. *Surveyor*, vol. 81, no. 2102, May 6, 1932, p. 483. Abstract of paper before Institution of Civil Engineers; tests of 2 by 2-in. concrete column allowed to stand for a long time at a given load, until plastic yield was reduced to a very small fraction of its initial value; stress-strain diagram for column subjected to long and continued high loading becomes ultimately concave to stress axis.

VOLUME CHANGES. Volume Changes of Early-Strength Concrete, E. R. Dawley. *Am. Soc. Testing Materials—Advance Paper*, no. 62, meeting June 20–24, 1932, 17 pp. Study of changes in length accompanying changes in temperature and moisture content of concrete specimens of various mixes and consistencies when made with ordinary and certain early-strength portland and cements; compressive strengths, coefficients of thermal and moisture expansion, and absorption were determined; freezing and thawing tests.

WATER-CEMENT RATIO. Cement-Water Ratio by Weight Proposed for Designing Concrete Mixes, I. Lyse. *Eng. News-Rec.*, vol. 108, no. 25, June 23, p. 897. Discussion, by R. Reimann, of article indexed in Engineering Index 1931, p. 328, from issue of Nov. 5, 1931.

CONSTRUCTION INDUSTRY

COSTS. Unit Bid Summary. *West. Construction News and Highways Builder*, vol. 7, no. 10, May 25, 1932, pp. 306, 308, 310, 312, and 314. Unit costs bid on bridge construction; water supply systems, street, and road work in California, Montana, Utah, and Nevada.

SCHEDULES. Engineering and Construction Schedules, H. W. Fuller and W. B. Rittenhouse. *Power Plant Eng.*, vol. 36, no. 11, June 1, 1932, pp. 444–448. Methods used by Byllesby Engineering and Management Corporation, doing work for operating companies from Pennsylvania to Oregon and from Minnesota to Oklahoma; methods of correlating costs and estimates were covered by the same authors in the N.E.L.A. issue of 1928; job preliminary, company master, and job detailed schedules; following-up schedules.

DAMS

CANADA. Glenmore Dam for Calgary Water Supply. *West. Construction News and Highways Builder*, vol. 7, no. 10, May 25, 1932, pp. 297 and 298. Features of concrete gravity structure with ogee section and spillway, 90 ft. high from bottom of cut-off wall to spillway crest, 1,050 ft. long.

CONCRETE GRAVITY, MARYLAND. Prettyboy Dam, Baltimore. *Engineer*, vol. 153, no. 3984, May 20, 1932, pp. 553 and 554. Baltimore, Md., has under construction on the Gunpowder River a second dam for the impounding of water; gravity-poured concrete structure of ogee section; spillway will be in central part of dam, with flanking non-overflow sections at abutments; dam is anchored to solid rock at all points; construction details.

EARTH, AUSTRALIA. Waroona Irrigation Waterworks, Western Australia. *Commonwealth Engr.*, vol. 19, no. 10, May 2, 1932, pp. 356 and 357. Description of Drakesbrook Dam 58 ft. high above bed of stream, having pug corewall extending down to granite foundation at a depth of from 7 to 26 ft.; length at crown is 570 ft. and top width 10 ft.; upstream slope 3 to 1 and downstream slope 2 to 1.

HOOVER DAM PROJECT, TUNNELS. Construction of Hoover Dam, N. S. Gallison. *Compressed Air Mag.*, vol. 37, no. 5, May 1932, pp. 3804–3810. Details of driving four tunnels which will divert the Colorado River around the dam site; tunnels are 56 ft. in diameter, lined with 3 ft. of concrete; combined length is 15,909 ft.; gantry crane used for pouring invert concrete.

HYDRAULIC GATES, DESIGN. Float-Operated Sluice Gates—I and II, A. W. Knight. *Mech. World*, vol. 91, no. 2363 and 2364, Apr. 15, 1932, pp. 359–361 and Apr. 22, pp. 395–398. Working principles of radical type of gate used for dealing with flood water; action of notch-fed floats and of automatic gear which ensures rapid return to normal level; performance of various types of gates; synchronous and fixed notch types; automatic notch type; relay control, using floats; conditions determining design; rising-notch control of push-buttons.

INDIA. Cauvery Metur Project. *Civ. Eng. (Lond)*, vol. 26, no. 310, Apr. 1932, pp. 32–33, 35, and 37–39. Features of great irrigation scheme in Madras; design and construction of concrete dam 5,300 ft. in length and 176 ft. in height; character of River Cauvery; history of project; cultivation seasons; quantities of water required; silting of reservoir; reservoir losses by evaporation and percolation; portable towers for mixing, hoisting, and distributing concrete.

ROCK-FILL, CALIFORNIA. Plans Approved for San Gabriel Dam No. I, E. C. Eaton. *West. Construction News and Highways Bldr.*, vol. 7, no. 2, June 10, 1932, pp. 332–336. General features of rock-fill flood-control dam, of 375 ft. maximum height above bedrock and 1,670 ft. long, requiring about 5,600,000 cu. yd. of rock; upstream slope will be protected by heavily reinforced concrete slabs, from 1 to 2 ft. thick, bearing reinforced laminated or "shingled" face made up of individual blocks 30 ft. square and 6 in. thick.

SPILLWAYS, GATES. Types of Gates Used on Dams in Europe, E. C. Molke. *Power*, vol. 75, no. 23, June 7, 1932, pp. 852 and 853. Review of design and construction features of various gate types that are most prevalent in Europe; diagrams illustrating different gate arrangements.

FLOW OF FLUIDS

CONCRETE. Abstract Science and Academic Theory in Relation to Hydraulic Flow in Concrete Pipes and Culverts, E. H. Essex. *Surveyor*, vol. 81, no. 2105, May 27, 1932, pp. 535–537. Critical review of formulas proposed in Great Britain and United States in the light of experimental results published by F. C. Scobey, D. L. Yarnell, S. M. Woodward, and others. Before Inst. Mun. and County Engrs.

IRRIGATION. Flowing Water—VI, J. M. Lacey. *Engineer*, vol. 153, no. 3986, June 3, 1932, pp. 604–606. Different systems of irrigation: by canals and feeders, by infiltration canals, and by flooding; a system, known as warping, for retaining matter in suspension in water, which consists in allowing waters highly charged with sediment to flow over land and to deposit matter they contain; method of cultivation; waterings. See also Engineering Index 1931, pp. 786, 788, and 1395.

MEASUREMENTS. Flow Measurement and Control—XXV, M. F. Behar. *Instruments*, vol. 5, no. 5, May 1932, pp. 115–126. Head meters; orifice type elements commercially available; "infinitely adjustable" primary elements; installations; American Gas Association report on orifice installations; connections to instruments containing mercury; American Meter Company's recommendations; Worcester "Piezometer Investigation."

FOUNDATIONS

CEMENTING. Increasing Bearing Power of Clay Soil, D. E. Moran and F. O. Dufour. *Eng. News-Rec.*, vol. 108, no. 20, May 19, 1932, p. 726. Use of grouting methods for improving clay soil directly under 9-in. reinforced-concrete floor with an area of 55,000 sq. ft., which was found to be settling; compacting of fill below slab by use of François cementation process.

STEAM POWER PLANTS, FOUNDATIONS. Power Plant Foundations, O. VonVoigtlander. *Power*, vol. 75, no. 24, June 14, 1932, pp. 881–884. Huge sums expended in building steam-generating stations make it imperative that considerable thought be given to plant foundations; necessity for adequate substructure; foundation problems and their solutions.

SUBWAY CONSTRUCTION, NEW YORK CITY. New York Subway Construction—IX, F. R. Harris. *Eng. News-Rec.*, vol. 108, no. 18, May 5, 1932, pp. 633–635. Underpinning elevated railroads; difficult task of supporting numerous elevated columns on Queens Plaza section handled by novel methods; addition of steel trusses to elevated railroad bents permits structure to be carried on two columns instead of four; permanent pipe-pile foundations; temporary pipe-line underpinning; pipe-pile towers for temporary support of columns later to be carried on subway roof.

HYDROLOGY, METEOROLOGY, AND SEISMOGRAPHY

EROSION. Toward a Theory of Morphologic Significance of Turbulence in the Flow of Water in Streams, J. B. Leighly. *Univ. Calif. Publ. in Geography*, vol. 6, no. 1, 1932, 22 pp. Discussion of interaction of stream and bed based on observations in natural and artificial channels.

RAIN AND RAINFALL. Measurement. Rainfall—IV. *Water and Water Eng.*, vol. 34, no. 403 May 20, 1932, pp. 209–212. Records from ordinary and self-recording gages; analysis of records.

IRRIGATION

UNITED STATES. Résumé of Work Accomplished During Calendar Year 1931 and Proposed for Calendar Year 1932, R. F. Walter. *Reclamation Era*, vol. 23, no. 6, June 1932, pp. 105–108. Review of work of U.S. Bureau of Reclamation; new projects or features authorized; new projects proposed during 1932; appropriations available; dams completed or under construction; canal and lateral construction; drainage construction; power and pumping plants; clearing Jackson Lake Reservoir; operation and maintenance.

WASHINGTON. Construction Work on Federal Reclamation Project, M. Mason. *Am. Soc. Civ. Engrs.—Proc.* vol. 58, no. 5, pt. 1, May 1932, pp. 790–795. Discussion, by A. Ruettgers of paper ndexed in Engineering Index 1931, p. 788 from ssue of Oct. 1931.

LAND RECLAMATION AND DRAINAGE

CULVERTS, CONCRETE. Reinforced Concrete Culverts, J. H. H. Wilkes. *Roads and Road Construction*, vol. 10, no. 113, May 2, 1932, pp. 133–135. Analysis of stresses, principles of design, and systems of reinforcement; numerical examples.

MATERIALS TESTING

CAST IRON, TESTING. Testing of Iron Castings, A. W. Walker. *Foundry Trade Journal*, vol. 46, no. 817, Apr. 14, 1932, p. 233 and (discussion) pp. 233–235. Factors influencing strength; traverse test; Brinell hardness; special cast iron. Before Inst. Brit. Foundrymen.

CEMENT SETTING. Determination of Setting Time of Portland Cement, A. C. Davis. *Cement and Cement Manufacturer*, vol. 5, no. 5, May 1932, pp. 166–172. Review of tests for setting time; Vicat apparatus; determination of initial and final setting time; tests for normal consistency of cement paste.

TIMBER, SPECIFICATIONS. Report of Committee D-7 on Timber. *Am. Soc. Testing Materials—Advance Paper*, no. 68, meeting, June 20–24, 1932, 9 pp. Activities of subcommittees; proposed tentative volume and specific gravity correction tables for creosote, creosote coal-tar solution (up to 50 per cent tar), and coal tar.

NON-FERROUS METALS, SPECIFICATIONS. Report of Committee B-2 on Non-Ferrous Metals and Alloys. *Am. Soc. Testing Materials—Advance Paper*, no. 19, meeting, June 20–24, 1932, 3 pp. Subcommittees on pure metals in ingot form, white metals, methods of chemical analysis, nomenclature of metals and alloys.

PIPE, VITRIFIED CLAY, SPECIFICATIONS. Report of Committee C-4 on Clay Pipe. *Am. Soc. Testing Materials—Advance Paper*, no. 52, meeting, June 20–24, 1932, 14 pp. Proposed tentative specifications for clay sewer pipe.

TESTING MACHINES, CALIBRATION. Full-Load Calioration of 600,000-Lb. Testing Machine, H. F. Moore, J. C. Othus, and G. N. Krouse. *Am. Soc. Testing Materials—Advance Paper*, no. 88, meeting June 20–24, 1932, 5 pp. Calibration of screw-power, balance, beam-testing machine; calibration made by use of two 10,000-lb. standard weights and an elastic bar fitted with delicate strainometer; after 27 years of rather severe service the testing machine was found to have still a high degree of accuracy and sensitivity.

PORTS AND MARITIME STRUCTURES

PORT STRUCTURES, GREAT BRITAIN. Southampton Docks Extensions, Western Shore. *Civ. Eng. (Lond.)*, vol. 26, no. 310, Apr. 1932, pp. 43, 45, and 47–48. Description of work being carried out by the Southern Railway Company, including reclamation of 400 acres of mud lands, construction of new deep water quay, 3,800 ft. in length, and a new 1,200-ft. graving dock.

SEA WALLS, GREAT BRITAIN. Sea Walls in Kent, M. Du-Plat-Taylor. *Structural Engr.*, vol. 10, no. 4, Apr. 1932, pp. 162–176 and (discussion) no. 5, May 1932, pp. 237–240. Geography and history of Romney Marsh; design and construction of about 1½ miles of concrete sea wall, most of it in step form; also construction of concrete sewer outfall and repair of wooden groins.

ROADS AND STREETS

ASPHALT. San Ardo Penetration Pavement Tests, C. L. McKesson. *West. Construction News and Highway Builder*, vol. 7, no. 10, May 25, 1932, pp. 299–300. Report demonstrating the increased efficiency of asphalt when applied in the form of emulsion, based on 5 years of observation and testing on California coast highway.

BITUMINOUS. Large Crusher-Run Stone Used in Mixed-in-Place Tar Road, H. L. Tilton. *Pub. Works*, vol. 63, no. 6, June 1932, pp. 17–18. Construction practice developed by Vermont Department of Highways in section of mixed-in-place surface 4.79 miles long in the town of Concord on Route U. S. 2; stone used was crusher-run material passing screen with circular openings 2½ in. in diameter and retained on screen with a circular opening ¾ in. in diameter.

CONCRETE. Maintaining Rigid Type Pavements by Hydrostatics, O. C. Dahlman. *Am. City*, vol. 46, no. 6, June 1932, pp. 59 and 60. American practice in maintaining highway grade by use of mud jacks; handling shrinking backfill.

CONSTRUCTION. To Blast or Not to Blast, C. L. Woolley. *Am. City*, vol. 46, no. 6, June 1932, pp. 61–63. Description of Rhode Island practice of accelerating and obtaining complete settlement and subsidence of fills over swampy areas; making fills according to types of swamps or bogs; explosives needed to break heavy mats; fills settled by blasting; costs.

EXCAVATION WORK. Cutting Down Sand Hill with Power-Driven Elevating Grader. *Contractors and Engrs. Monthly*, vol. 24, no. 5, May 1932, pp. 15 and 16. Description of job at Aurora, Ill.; moving 2,200 yd. per 10-hour day in 20,000-yd. cut with frequent turns and culverts at either end.

FINANCING. Roadbuilding Reduces Taxes in Illinois County, B. Jordan. *Eng. News-Rec.*, vol. 108, no. 22, June 2, 1932, pp. 788–790. Township initiative with county aid and control of construction has provided all-year road system without excessive debt or tax burden; township bond issues; maintenance costs; tax rates and decreases in townships in Iroquois County, before and after bonds for single-track roads were retired; construction practice.

GUARD RAILS. Design of Highway Guard-Rail Dictated by Tests, S. B. Slack. *Eng. News-Rec.*, vol. 108, no. 23, June 9, 1932, pp. 824–826. Field tests on several types of guard-rails undertaken by the state highway board of Georgia; construction of runway about 400 ft. long on 9 per cent grade; vehicles released along runway and guided into section of guard-rail to be tested; motion-picture camera invaluable test aid; tests point to definite design theory and structural type; diagram of forces when motor vehicle strikes guard-rail at angles; support of guard-rail.

HIGHWAY ADMINISTRATION, GREAT BRITAIN. Law of Highways—IV, H. F. Payne. *Inst. Mun. and County Engrs.—Journal*, vol. 58, no. 23, May 10, 1932, pp. 1693–1702. Private and public bridges; need for extension of highway law. (Concluded.)

HIGHWAY TRAFFIC SURVEYS. Highway Traffic Capacity, A. N. Johnson. *Pub. Roads*, vol. 13, no. 3, May 1932, pp. 41–46. Study of relative traffic capacity of 2-lane, 3-lane, and 4-lane highways, undertaken as a cooperative arrangement between the U.S. Bureau of Public Roads, State Roads Commission of Maryland, and the University of Maryland; traffic capacity and congestion; distribution of traffic counts by geographic location and number of lanes; consistency of observers' judgment.

LOW COST. Coarse Aggregate Type of Road Mix. *Can. Engr.*, vol. 62, no. 23, June 7, 1932, pp. 13, 14, and 47–50. Recent practical developments in the design and construction of low-cost road surfaces; size and grading of aggregate; quantity of bituminous materials; primer and binder tar; asphalt for priming subgrade asphalt for cold weather and mixing; preparing foundation; applying prime coat; spreading aggregate; first and second mixing; applying seal coat; recommendations on road mix. Before Am. Road Bldr's. Ass'n.

MAINTENANCE AND REPAIR. Economy of Maintenance by Contract, H. J. Kirk. *Constructor*, vol. 14, no. 5, May 1932, pp. 15 and 16. Survey of the practice of many states leading to the conclusion that "all operations whose cost can be accurately estimated in advance, making possible use of open competitive bids, should be done by contract method." Before Am. Road Bldrs. Convention, 1932.

MOUNT VERNON MEMORIAL. Mount Vernon Memorial Highway, R. E. Royall. *Military*

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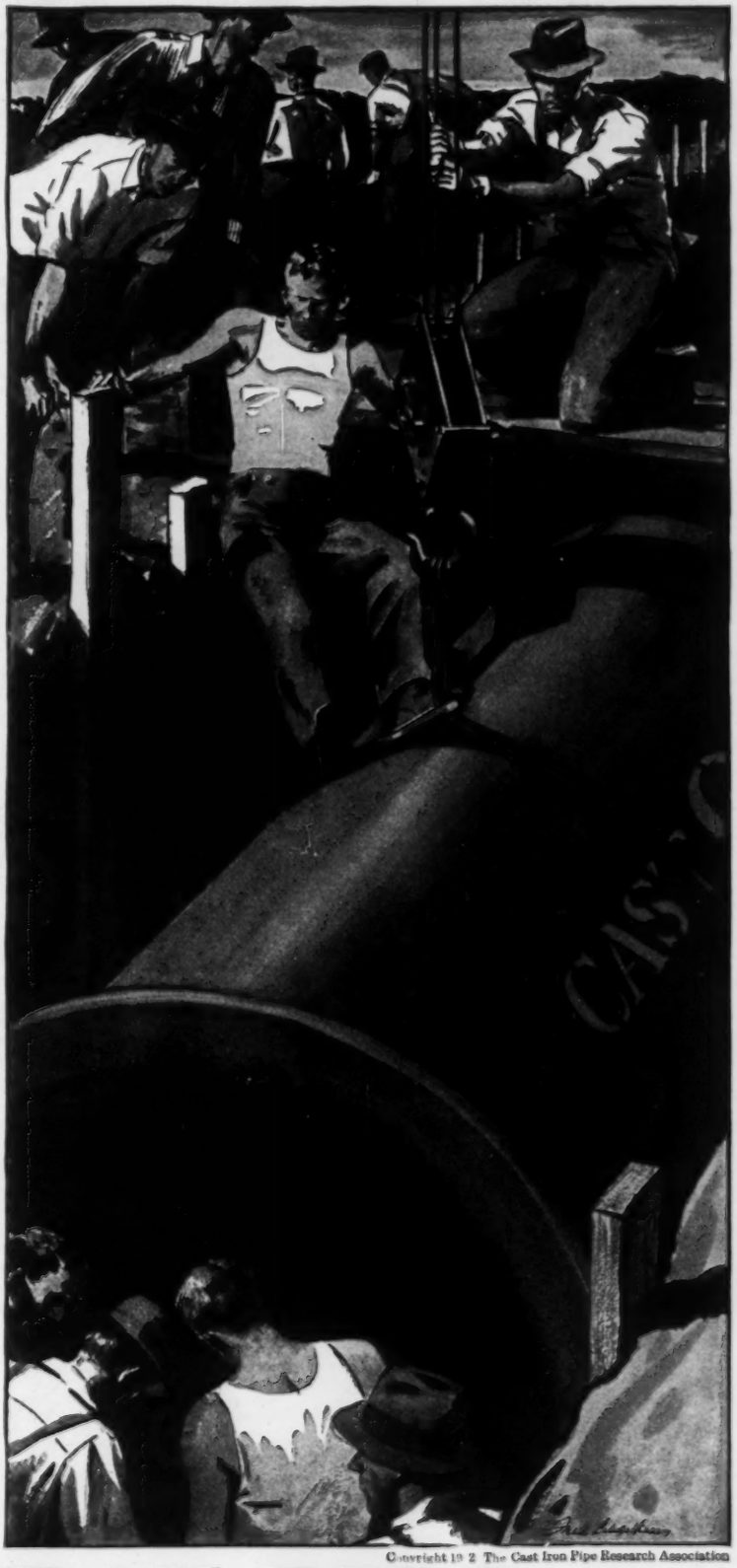

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CAST IRON PIPE

Engr., vol. 24, no. 135, May-June, 1932, pp. 238–242. Location influenced by character of project; unusual features of design; terminal at Mount Vernon; bridges harmonize with parkway; pavement design; landscaping, lighting, and other features.

RAILROAD CROSSINGS, ACCIDENT PREVENTION. Difference of One. H. A. Rowe. *Nat. Safety News*, vol. 25, no. 5, May 1932, pp. 11 and 63. Grade crossing accidents claimed one more victim in 1931 than in 1922, although the number of automobiles in operation on highways had more than doubled.

SAFETY ZONES. Design and Lighting of Safety Zones. *Roads and Streets*, vol. 75, no. 6, June 1932, pp. 251–253. Report of Committee on Traffic presented at the 1932 convention of the American Road Builders Association; summary of types of construction and lighting of standard safety zones; costs.

SAND CONTROL. Preventing Sand Drifts on Highways. *Eng. News-Rec.*, vol. 108, no. 22, June 2, 1932, pp. 801–802. Methods of checking sand drift formation by fences, planting, spraying, and blanketing, including examples from railway practice.

SANITARY ENGINEERING

CANADA. Progress in Sanitary Engineering, A. E. Berry. *Can. Engr.*, vol. 62, no. 21, May 24, 1932, pp. 21–23 and 52–54. Water works, sewerage, and sewage disposal projects undertaken in Ontario in 1931; Canadian unemployment relief; supervision of water works; water chlorination installations.

SEWERAGE AND SEWAGE DISPOSAL

BRAZIL. Rio de Janeiro Sewered by Private Company. *Eng. News-Rec.*, vol. 108, no. 24, June 16, 1932, p. 852. History and main features of the sewerage system of Rio de Janeiro, constructed and operated by a private British company; flat rate charged for use of sewers and sewage treatment.

DUBLIN, IRELAND. Development of Dublin Main Drainage (1906–1931), H. Nicholls. *Inst. Mun. and County Engrs.—Journal*, vol. 58, no. 24, May 24, 1932, pp. 1735–1745 (discussion), 1745–1748. History of Dublin sewerage system and description of present works; bio-aeration treatment.

EXPLOSION. Cause of and Methods of Preventing Explosions in Sewers, J. J. Jessup. *Mun. Sanitation*, vol. 3, no. 5, May 1932, pp. 197 and 198. Gas conditions which cause trouble; combustible gas indicator; illuminating gas; London explosions. Before Am. Soc. Mun. Engrs.

IMHOFF TANKS. Imhoff Tank Operating Costs at Stockton Sewage Plant, W. B. Hogan. *Mun. Sanitation*, vol. 3, no. 5, May 1932, pp. 200–201. Cost data on operation; methods of handling sewage.

INCINERATORS. Incineration of Sewage Screenings and Sludge, H. W. Lincoln. *Pub. Works*, vol. 63, no. 5, May 1932, pp. 22–24. Principles of process; amount of gas required to incinerate screenings of various moisture contents.

OPERATION. Placing Woonsocket Activated Sludge Plant in Operation, I. O. Lacy. *Pub. Works*, vol. 63, no. 5, May 1932, pp. 25–27 and 64 and 65. Sewage flow; compressors and air; pumps and other mechanical equipment; return sludge control; detailed account of operating power cost.

PLANTS, MAINTENANCE AND REPAIR. Clogged Filtros Plates Rejuvenated with Blow Torch at Milwaukee. *Eng. News-Rec.*, vol. 108, no. 21, May 26, 1932, p. 756. Outline of method accidentally discovered in Milwaukee sewage disposal plant; cost data.

SCREENINGS. Some Practical Aspects of Sewage Screenings Incineration, W. W. Young. *Water Works and Sewerage*, vol. 79, no. 6, June 1932, pp. 191–193. Experience of Westchester County Sanitary Sewer Commission with apparatus for disposing by incineration of all sewage screenings from both coarse and fine screens; two types of incinerators used; fuel consumption; operating factors and deterioration.

SEWERS, CONCRETE. Concrete Sewer at Blackburn. *Concrete and Constr. Eng.*, vol. 27, no. 5, May 1932, pp. 264–270. Construction of new sewer 4 1/4 miles long, having a discharge capacity of 27,500,000 gal. per day; involving several siphons and vertical falls, including one of 70 ft., also bridge structures carrying sewer across rivers and depressions, among them a concrete arch of 180-ft. clear span.

SEWER TUNNELS, LINING. Small Tunnel Sewer "Gunited," K. O. Guthrie. *Can. Engr.*, vol. 62, no. 22, May 31, 1932, p. 10. Application of gunite to tunnel lining; repairing and enlarging Sparks Street sewer in Ottawa, Ont.; work done in tunnel and only during night.

SLUDGE. Loss of Volatile Matter by Drying Sewage Sludge Before Incineration, W. Rudolfs and W. H. Baumgartner. *Water Works and Sewerage*, vol. 79, no. 6, June 1932, pp. 199–201. Report of New Jersey Agricultural Experiment Station on experiments made to determine optimum temperature for sludge drying from standpoint of least volatile matter distilled off; loss of volatile matter from dry solids at various temperatures after different times of exposure; relation of volatile matter lost to time of exposure; loss of moisture and volatile matter with heating of sludge.

STREET CLEANING AND REFUSE DISPOSAL

GREAT BRITAIN. Public Cleansing, J. C. Dawes. *Surveyor*, vol. 81, no. 2107, June 10, 1932, pp. 579 and 580. Abstract of presidential address before Manchester Conference of the Institute of Public Cleansing; commentary on current public cleaning practice, house and trade refuse; storage of refuse at dwelling-houses; refuse collection and disposal; street-cleansing service; organization and administration; costs.

REFUSE INCINERATORS. Round Table. *Mun. Sanitation*, vol. 3, no. 5, May 1932, pp. 207–211. Practical discussion of garbage and rubbish disposal by incineration; trend of American cities with regard to methods of disposal; incinerator operation as cause of smoke or odor nuisance.

SURVEYING

AERIAL. Interpretation of Geology from Aerial Photographs—II, D. Gill. *S. African Min. and Eng. Journal*, vol. 43, part 1, no. 2116, Apr. 16, 1932, pp. 164–166. Notes on study of 15 exposures made for experimental purposes over the Sheba Hills in the Barberton district; geological influences; general remarks.

TRAFFIC CONTROL

ACCIDENTS, PREVENTION. Experience Points Way to Traffic Safety, E. Dana. *Nat. Safety News*, vol. 25, no. 6, June 1932, pp. 14 and 15. Balanced program for reduction of traffic accidents outlined; based upon experience of cities, large and small, which have carried on successful programs.

TRAFFIC SIGNS, SIGNALS, AND MARKINGS. Reflector Signs Adopted for California Highways. *Pub. Works*, vol. 63, no. 6, June 1932, pp. 25 and 26. Description of system of reflectorized directional signs at important road intersections developed by the California Division of Highways.

TUNNELS

BOSTON. Boston Builds Subaqueous Vehicular Tunnel at Record Speed, C. H. Vivian. *Compressed Air Mag.*, vol. 37, no. 5, May 1932, pp. 3788–3794. Construction of East Boston Vehicular Tunnel; single fabricated-steel tube lined with concrete, 31 ft. in diameter, 5,650 ft. between portals, of which 4,850 ft. will be driven by shields.

RAILROAD, ELECTRIFICATION. Boston and Maine Repairs Trolley Supports in Hoosac Tunnel, L. C. Winship. *Ry. Elec. Engr.*, vol. 23, no. 5, May 1932, pp. 115–117 and 125. After 21 years of service, corrosion necessitated the application of new tape and asphalt cement on bracket bars; relatively few roof bolts need replacement; special work train provided.

VEHICULAR, GREAT BRITAIN. Mersey Tunnel. *Civ. Eng. (Lond.)*, vol. 26, no. 310, Apr. 1932, pp. 49, 51, 53, and 48. Comparative study of costs of ventilation which led to the adoption of an upward semi-transverse system; conclusions from experiments.

WATER SUPPLY, CALIFORNIA. Hetch Hetchy Coast Range Tunnel. *West. Construction News and Highways Builder*, vol. 7, no. 10, May 25, 1932, pp. 278–280. San Francisco Public Utilities Commissions call for bids for completion of tunnel driving and lining on the coast range division of the Hetch Hetchy Aqueduct, involving 20,400 lin. ft. of excavation and 109,700 lin. ft. of concrete lining.

WATER SUPPLY TUNNELS, MAINTENANCE AND REPAIR. Concrete Water Conduit Tapped While in Service, E. A. Prokop. *Eng. News-Rec.*, vol. 108, no. 24, June 16, 1932, pp. 858 and 859. Principle of diving bell successfully applied, at Detroit filter plant, in making large connection between concrete filtered-water conduit and adjoining closed weir chamber, without taking the conduit out of service; the opening into the conduit was made from within a modified pneumatic caisson, the wall section being cut away in four successive steps, while compressed air held down the level of the water.

WATER PIPE LINES

ENAMEL LINING. Example of Long-Time Service of Baked Coating on Water Pipe, A. H. Sabin. *Am. Soc. Testing Materials—Advance Paper*, no. 84, meeting June 20–24, 1932, 4 pp. Example of pipe built in 1895 as part of the city water supply of Pittsburgh; pipe was coated with varnish enamel baked at 400 deg. fahr. for two hours; other examples.

MAINTENANCE AND REPAIR. Difficult Pipe Repair, W. W. Brush. *Water Works Eng.*, vol. 85, no. 10, May 18, 1932, pp. 634–635 and 662. Repairing leak at 6th Ave. and 50th Street, New York City; main is 100 ft. below the surface and encased in 25 ft. of concrete; copper tubing was inserted in damaged main section; equipment used in repairing pipe.

SAN FRANCISCO. Only Five Miles of Tunnel Remain to Be Excavated on Hetch Hetchy Project, M. M. O'Shaughnessy. *Water Works Eng.*, vol. 85, no. 9, May 4, 1932, pp. 584 and 587–588. Progress report on the construction of the Sierra Mountains water supply systems; features of Coast Range tunnel; Red Mountain Bar Siphon; San Joaquin Pipe Line; Corral Hollow Pipe Line; storage increased; present state of finances.

WATER RESOURCES

FORESTS. Seattle's Watershed Controversy, B. E. Hoffman. *Journal Forestry*, vol. 30, no. 5, May 1932, pp. 558–568. Review of data on the effect of forests on precipitation, run-off, air temperature, and erosion presented in connection with a lawsuit brought by the City of Seattle in an attempt to rid its watershed of lumbering operations; adverse decision rendered by the courts of the State of Washington.

SUPPLY, UNITED STATES. Surface Water Supply of United States 1929—XII, North Pacific Slope Drainage Basins. *U.S. Geol. Survey Water-Supply Paper*, no. 692, 1932, 190 pp., 25 cents. Results of measurements of flow made on streams in United States during the year ending September 30, 1929.

WATER TREATMENT

COAGULATION. Coagulation with Lime and Chlorine, E. K. Ventre. *Am. Water Works Ass'n—Journal*, vol. 24, no. 5, May 1932, pp. 733–736. Treatment of low turbidity, colored water; chlorination of coagulated water in regular iron-sulfate-lime treatment; utilizing natural iron content of water for coagulation; combination of iron and chlorine is most efficient as a taste remover.

FILTRATION, MATERIALS. Granulometric Test for Sand, C. M. Wichers and E. Jacobs. *Am. Water Works Ass'n—Journal*, vol. 24, no. 5, May 1932, pp. 705–715. Outline of system based on specific filtration factors—namely, surface area of grains per unit volume of compact sand, and volume of voids per grain of compact sand; comparison of new coefficients with old.

IRON REMOVAL. New Iron Removal Plant at Warrenton, N.C., M. F. Trice. *Am. Water Works Ass'n—Journal*, vol. 24, no. 5, May 1932, pp. 716–724. Equipment and operation of plant serving a population of 1,000.

RESERVOIRS, CONTAMINATION. Chironomus in Water Supply, C. A. Hechmer. *Am. Water Works Ass'n—Journal*, vol. 24, no. 5, May 1932, pp. 665–668. Experience of Washington Suburban Sanitary District filtration plants with redworm contamination of uncovered filtered water reservoirs.

SOFTENING, GREAT BRITAIN. West Cheshire Water Company. "Permutit" Water Softening Installation. *Water and Water Eng.*, vol. 34, no. 403, May 20, 1932, pp. 197–199. Equipment and operation of plant designed for a capacity of 750,000 gal. per day, comprising a battery of 14 units, each unit 9 ft. in diameter.

TASTE AND ODOR REMOVAL. Taste and Odor Elimination, J. R. Baylis. *Am. Water Works Ass'n—Journal*, vol. 24, no. 5, May 1932, pp. 635–656 (discussion) 656–659. Relative merits of various treatments; qualities of tastes; progress in taste elimination; methods of preventing or removing objectionable tastes; tabulated summary of taste elimination practices; experiments with taste-elimination treatments. Bibliography.

WATER WORKS ENGINEERING

FILTRATION PLANTS, CHINA. Developing Water Supply from Polluted Chinese River, H. Stringer, *Eng. News-Rec.*, vol. 108, no. 23, June 9, 1932, pp. 833–837. Construction of rapid filters for a million people in International Settlement, Shanghai; continuous method of operating settling basins; per-capita consumption of water in Shanghai; mud channels cleaned by air lift, discharging into temporary wooden channels; to minimize settlement, eight filters are designed as four independent units, with independent pipe gallery and operating floors between each set of four filters; cost data.

IRELAND. Water Supply of Greater Dublin, M. A. Moynihan. *Inst. Mun. and County Engrs.—Journal*, vol. 58, no. 24, May 24, 1932, pp. 1716–1730 (discussion), 1730–1734. History of water works since 1244; description of present system and methods of operation; chemical analysis of Dublin water supply; pipe corrosion and its control.

TACOMA, WASH. Hood Street Booster Station for Tacoma, W. A. Kunigk. *West. Construction News and Highway Builder*, vol. 7, no. 10, May 25, 1932, pp. 283–286. Features of reconstructed water works with capacity of 57 m. g. d., including auxiliary well supply; booster pumping plant with capacity of 20 m. g. d.; 30-in. diameter electric-welded steel discharge pipeline, built of 5/16-in. plate; surge tank 20 ft. in diameter and 24 ft. high.

WELLS, DESIGN. Determining Type of Casing and Proper Diameter of Wells, A. Blakesley. *Water Works Eng.*, vol. 85, no. 11, June 1, 1932, p. 692. Fiction of casing; percolation; turbine installation; cost of well drilling; drainage wells. Before Am. Water Works Ass'n.